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REPORT ON LAC AND SHELLAC

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INTRODUCTION.

The lac industry has passed through many developments and has experienced many turns of fortune. From ancient days lac-dye was held in high esteem for its bright red colour, and the name still lingers as Crimson "lake." Two generations ago, however, it began to yield place to vegetable and chemical substitutes and, within the space of a few years, the trade had dwindled to nothing. In 1868-9 the exports from India were valued at nearly eight lakhs of rupees; ten years later, they had diminished by one-half in volume and their value stood at only two lakhs. Luckily the value once attached to the dye passed with interest to its resinous by-product lac, which has been in demand since early days for varnishes and polishes, and during the current century for other purposes also, such as gramophone records and the manufacture of electrical apparatus. In 1888-9, when exports of the dye had practically ceased, the exports of shellac, which is lac manufactured in flake or "shell" form, were valued at nearly thirty-two lakhs of rupees. Ten years later the value of the trade had risen to over seventy lakhs, and ten years later again, in 1908-9, a total of nearly two and a half crores was reached.

The history of the trade is not, however, one of steady progress, for it has always been liable to serious fluctuations of price. The reasons will be given later in some detail. For the present, it will suffice to remark that the lac industry is very widespread in India, which is practically the only source of supply; that cultivation is everywhere in the hands of village labourers, of little education and scanty means, who neglect the crop when prices are low and are too often tempted, when prices rise, to strip their trees of the brood-lac on which subsequent production depends; and that, as a result of these and other factors, while foreign markets can be quickly glutted, they are nervous of a shortage at their only base of supplies; and prices oscillate violently in consequence. It is moreover an interesting feature of the trade that the London and Calcutta prices follow closely, in inverse, any important variations in the quantities stored in London warehouses; for such variations afford a safe index to the strength or weakness of the demand.

On the outbreak of war, London stocks had attained the very high figure of nearly 100,000 cases and the price was only 61*s.* per cwt. Normal commercial demands were cut off and at first the military demand for shellac, for the inner coating to shells and for electrical and other fittings, was not of itself sufficient to stimulate the trade By August 1915, London stocks and prices were much what they had been the year before, and it was not until 1916 that stocks were reduced; on the 1st December of that year they stood at 56,000 cases, while the price had risen to 139*s.*

By this time, the military demands for shellac on account of Great Britain and the Allies had increased; and, in view of the serious rise of prices in London, measures of control became necessary. In December 1916 a delivery price of Rs. 42 per maund for Government shellac f.o.b Calcutta was agreed to at a conference between Government and the principal Calcutta shippers. Open market prices in Calcutta were more than double that rate, and the loss on each Government consignment was made good by the shipper on his sales to foreign consumers.

Although, throughout the period of control, Calcutta prices remained fairly constant between Rs 90 and Rs 100 per maund, the London price steadily increased from 144*s.* in January 1917 to the enormous figure of 450*s.* per cwt. in April 1918, by which time the stocks had declined from 54,000 to 18,000 cases. Thereafter supplies improved slightly and by December 1918 the price had fallen to 320*s.* These prices, of course, represented the rates which the private consumer in London was willing to give against declining stocks with no near prospects of replenishment. The Ministry of Munitions had throughout secured its supplies at the Calcutta price of Rs. 42 per maund, plus the usual freight and handling charges.

In December 1918, war control came to an end and the reversion to normal conditions began. Although foreign markets were starved of lac, it was naturally some time before the various manufacturing industries recovered sufficiently to stimulate the demand Moreover, Government was known to possess considerable stocks and this knowledge depressed all markets. The London market fell from 303*s.* in January 1919 to 205*s* in April. Subsequently there was a recovery as the various industries consuming shellac awoke to their former activities. From that month London prices rose steadily again, the

rise being accentuated by poor crops and short supplies in India during that year. Early in December the price was 570*s.* and in January 1920 it touched 880*s.* With every indication of a bumper crop coming forward, prices have since declined. There is no doubt that they had reached an unhealthy level and all in India who have the true interests of the industry at heart are anxious for a reversion to normal levels and normal trade conditions.

From the stand-point of May 1920, one may review the present position briefly as follows:—

The war has naturally altered both the value and the direction of India's lac trade. During 1912, a typical pre-war year, the total exports stood at 254,000 cases. The principal customers were:—

	Cases.
The United Kingdom taking	50,000
The United States taking	111,000
Germany, Holland and Austria taking	63,500
France taking	16,500

During 1919, a year when the crops were poor and freight space still short, the total exports amounted to 205,000 cases.

Germany and Holland took only 450 cases direct from India, and the principal customers have now become:—

	Cases.
The United Kingdom taking	56,000
The United States taking	139,000
France taking	5,450
Japan taking on transit for the western ports of America... ...	600

The 1920, crop prospects are good, but foreign consumers are buying freely and the reduction in the German demand is not noticed. No satisfactory substitute has appeared on British or foreign markets, even under war compulsion. In short, all foreign conditions are favourable to the industry of which India holds what is virtually a world's monopoly.

No monopoly in the world, however, can be considered permanently safe. The greater its value, the greater the inducement to the manufacture of rival products. The importance of lac to many manufacturing industries of the West, and its present high value, expose it to serious risks of attack. Unfortunately, also, the industry is encrusted with local prejudice and handicapped by unscientific methods.

is widely scattered over India. The principal districts of production alone, where cultivation is concentrated, cover a greater total area than that of the British Isles. The propagation and collection of lac are still primitive and uneconomic, manufacture is careless, adulteration rife Prices fluctuate seriously from season to season; and, in the absence of authoritative reports on crop conditions, speculation flourishes. A wider knowledge of scientific methods and a closer organisation are necessary to stabilise the trade

These are the circumstances in which the present enquiry was ordered by Government Fortunately, as the defects are generally primitive, so are the remedies in most cases simple, and the real object in view, namely to stimulate production on economic lines, is one which must appeal to all interested parties whether cultivators or manufacturers, dealers, brokers or merchants.

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CHAPTER I.

THE LAC INSECT.

No one has suggested a better derivation of the word "lac" than that from the Sanskrit *Laksha* (Hindi Lakh) meaning a hundred thousand. The allusion* is to the vast numbers of minute lac insects which emerge at the period of swarming and settle on the young shoots of the "host"-tree, to suck its juice and exude the lac of commerce.

The following brief account of the insect is offered only as a necessary preliminary to subsequent remarks and recommendations on the subject of cultivation, collection, manufacture, and research. For, although the life-history and habits of the insect have already been studied to some extent, more especially by Carter, Imms, and Misra, our knowledge is still so incomplete that no general account can be other than superficial and fragmentary. The present account is based on earlier ones and on personal observation, while Appendix III indicates some of the more obvious gaps in our knowledge that ought to be filled up if we wish to obtain any effective control over the insect and the crop.

The lac insect, *Tachardia lacca*, belongs to the group of Coccidæ or scale-insects, so called from the scale or outer covering which is characteristic of most of them. This "scale" consists of various excretions and secretions, together with moulted-off skins, and it acts as a protective shield to the insect's body. In the case of the lac insect the "scale" is particularly thick and massive, and is composed of the amber-coloured resinous substance known as "lac", the raw material from which shellac is manufactured. Motionless under this amber shield the little purple insect lives most of its life, sucking through its delicate hair-like proboscis the juices of the plant to

* c.f The descriptive term "millions" applied to the little West Indian fishes that are sometimes used to destroy mosquito-larvæ.

which it has fixed itself. Several varieties of the lac insect have been described, but as it is unknown how far the differences between them are of any importance from the practical point of view, we may for the time being consider them as one.

The life of the female insect is about six months, so there are two generations ("broods") in the year. The summer brood hatches and emerges as swarms of tiny larvæ* in the hot weather or early rains, it attains maturity during the cold weather, when its young ones likewise emerge from under the lac and constitute the winter brood, which will ultimately reproduce itself in the following hot weather. There are thus two periods of emergence or "swarming" of the young insect, and also two crops of lac, the summer *brood* emerging from the summer *crop* of lac, under which their dead mothers from the winter brood lie hidden, and the winter brood from the winter crop.

The swarming out of the newly hatched larvæ is a remarkable sight. It usually happens in the early morning, and most often, it is said, on a sunny day. Through holes in the crust of lac that has been produced by their mother, there emerge a great swarm of tiny slow-moving light crimson or mauve specks. These are the larvæ, and they move slowly about until they have found suitably tender shoots or twigs, one to two years old, on which they can establish themselves. Imms states that they can travel at least twelve feet without getting exhausted, but it is said that if they fail to find a suitable resting place on the first day they will rarely survive to find one at all. They take no food during this search and do not, as is often believed by the country-folk, return at night to take shelter in the resinous home from which they emerged.

The swarming period in any given locality generally lasts from three weeks to a month, but the majority of the larvæ usually appear in the first few days. It is noteworthy that the swarming period of lac insects growing on Kusum trees (which produce the best lac) is about a month later than that of lac insects on most other trees During the whole period there is often a very heavy mortality from unsuitable climatic conditions, hereditary foes, and exhaustion, but a larva that succeeds in weathering these perils and finding a young

* Here the name "larvæ" is used to denote any stage of the insect up to the time when it begins to produce lac.

and succulent twig, at once proceeds to settle down. This it does by piercing the soft bark of the twig by means of an exceedingly slender beak or proboscis, finer than a hair, through which it sucks the juices of the twig.

Once fixed, it might be imagined that the insects had no further dangers to survive, except those due to enemies, but there is evidence to show that in the first month of their existence on the twig there is often a heavy mortality among them. The cause of this is unknown; it may be merely constitutional weakness due to poor stock, over-exhaustion in finding a fixing-spot, or failure to "strike oil" in sufficient abundance for proper nourishment. Whatever the cause, the mortality may amount (as shown by Misra) to 25 per cent. of the brood, and is thus by no means negligible. Besides this loss after fixation, large numbers of the newly-emerged larvæ frequently perish while still wandering in search of a fixing-spot. They are then very susceptible to unfavourable climatic conditions, frost, dry dusty winds, hail or heavy rain, while they are also carried by wind away from their food-plant and may in this way be removed to considerable distances. It is thus evident that the time of swarming, fixation, and the first week or two after fixation, is a critical period of the insect's life; and that the conditions that prevail during this period will largely influence the welfare of the brood and therefore its output of lac.

The female larvæ that effect a satisfactory fixation are fixed for life. They at once begin, by some process which is not understood, to produce the waxy and resinous matter known as lac, as well as a sugary excrement or "honey-dew". This latter drips from the colonies on the twigs above down on to the leaves below, covering them with a sugary glaze that affords nourishment to a dirty-looking black mould. This mould has been identified by Mr. E. J. Butler, Imperial Mycologist, as consisting of species of *Capnodium* and *Fumago*, and its presence is a characteristic and easily-recognized mark of lac-bearing trees. The lac itself is exuded, at least mainly, from various glands in the skin, and that produced during this first stage is small in amount and very transparent. The insect, however, now proceeds to moult, *i.e.*, cast its skin, and in doing so loses its legs and all power of locomotion. It now becomes a pear-shaped sac; where the stalk of the pear would be is an indefinite head and the delicate proboscis, and at the other end is a small spine and three

rather conspicuous pimples or processes. At the apex of two of these are breathing-holes (spiracles) leading to internal breathing-tubes (tracheæ), while the third bears the opening of the anus; here also is the genital opening, and it is obviously important that all these holes should be kept open and not blocked up by lac. We find that as the insect's coating of lac gradually thickens, these holes are not as might be expected obliterated, but remain open; and that from them protrude delicate snow-white filaments of a waxy substance whose presence may somehow prevent the resinous lac from gradually filling up these three important apertures. With good healthy stock this waxy fluff is so abundant that the lac looks almost white all over, and its amount gives a rough indication of the condition and general vitality of the brood. At the same time there is no reason to suppose that the destruction of these filaments (*e.g.*, by ants running over them) results in any appreciable damage to the insect beneath though the reverse has been stated. They are not (as has also been asserted) continuations of the tracheæ, and are probably no more vital structures than is, for example, our own hair.

The females of the summer brood become sexually mature in about six or eight weeks, and those of the winter brood in about three to four months. They have then a fairly thick covering of lac, and are ready for the males who have been developing alongside them.

The males have a different course of development to that of the females, and they are distinguishable from them in early life by the smaller size and different shape of their covering of lac, of which they produce much less than the females. They do not remain for their whole lives imbedded in the lac, but about the time when the females become ripe for pairing, generally August-September and March-April, they crawl out from their lac cells and reveal themselves as having not only legs but often (in males of the winter brood) wings as well. The males of the summer brood are stated to be always wingless.

Having safely emerged from the lac, the males crawl or (if winged) fly about and proceed to fertilize the females that they find, the long copulatory organ of the male reaching the female through the anal aperture in the lac.

This emergence of males, which may be spread over a month or more, is another critical period in the life of the brood. Not only

are the males delicate creatures who easily succumb to adverse conditions of weather and the attacks of predaceous insects, but the females only produce their full crop of lac after they have been fertilized. If unfertilized they produce but little, and probably die early and childless, though perhaps the possibility of parthenogenetic production cannot yet be altogether excluded.

After performing their proper function the males die off. The females, now nearly a sixteenth of an inch long, begin to secrete lac at a greater rate, presumably because they are taking more food to supply the needs of the very large family of young ones developing in their ovaries. Perhaps about a month after being fertilized the female dies; the eggs, or young, emerge from her body, which collapses into a mere sac, and seems by its contraction to leave a vacant space in the lac which shows as an "orange spot": after sheltering for a short time (a week?) under the lac, at a suitable opportunity the little swarm of tiny mauve dots emerges on the outer world, to wander in search of fresh succulent shoots and fix themselves as already described.

The details of the life-history that we have here briefly sketched cannot be filled in, as they are still for the most part unknown, but enough has been said to enable us to pick out a few points which will evidently have an important influence on the crop of lac produced by a given brood.

These are—

(1) The amount and quality of food obtainable from the plant on which the insects are fixed, dependent on the nature and habit of the plant, conditions of soil, weather, etc.

(2) The vitality and hardiness of the strain or variety of insect engaged in the production, and its general efficiency as a producer of lac from the juice of the particular plant on which it is fixed.

(3) Weather conditions, *e.g.*, presence or absence of hot drying winds, dust, frost, hail, heavy rain, at the time of swarming and fixation and at the time when the males are emerging. The general influence of climatic factors on the welfare, and therefore the distribution of lac insects.

(4) Prevalence of natural enemies of the insect or the host-plant; including various predators and parasitic animals, human thieves, and fungal or bacterial diseases.

Unfortunately, very little is accurately known about any one of these four points. With regard to (1) and (2) our ignorance at present is practically complete. We do not know what substances in the plant the lac insect really feeds on, or what condition of the plant favours the production of these substances; nor have we any clear ideas as to the characteristics of different varieties of the lac insect and their relative efficiency as lac-producers It is known that lac itself, including the lac-wax and dye that are also produced, is a complex substance made up of at least half a dozen different compounds; but of the physiological processes whereby it is made and secreted by the insect we are entirely ignorant.

As to point number three (weather and climate) we know that strong and dusty winds, frost, hail and heavy rain are all likely to cause serious loss at the critical periods of larval and male emergence; but as regards what may be called climatic distribution we have no definite or precise knowledge That is to say, given an acquaintance with the meteorological data relating to the temperature, rainfall, and humidity of any particular place, we cannot say definitely whether that place is climatically suited to the lac insect or not.

With few exceptions, insects are affected by climate far more than we are, and are unable to live a healthy life, or even live at all, outside their own particular limits of temperature and humidity. These limits thus decide the climatic suitability, or otherwise, of any geographical area for the cultivation of any given kind of insect; and in a case like that of the lac insect, where extension of cultivation is desirable, waste of money or energy may be avoided if the limits, and the optimum conditions which lie somewhere between them, are definitely ascertained.

All that we know at present is that areas where lac is at present most abundantly grown, namely, Chota Nagpur, Orissa, and the east of the Central Provinces, are generally over 1,000 feet above sea-level and enjoy a fairly temperate climate. The annual rainfall is from 50 to 60 inches, and occasional showers are secured during the winter and summer months, outside the regular rainy season The general humidity is low. Frost, although fairly common in parts

of the tract such as Damoh, can be avoided on the hill slopes, and hail, heavy tropical rains and dry hot winds are uncommon.

Point number four, relating to the enemies of lac, is the only one where a reasonable amount of accurate information is already available, and we owe this chiefly to the work of Imms, Chatterjee, and Misra. These observers are unanimous in attaching serious importance to the destruction of lac insects by natural enemies and parasites, and no one who has raised lac under observation is likely to disagree with them. Useful work has been done in identifying some of the more important parasites of the lac insect, but comparatively little is known regarding their habits, life-histories and distribution, or their relative destructiveness and the best means of combating them.

These four points are considered in a rather broader and more general sense in Appendix III on "Research", but it is as well that we should realize at the outset how very patchy and superficial our knowledge is as regards what may be called the biological side of the study of lac, that is to say, the side which deals with the two living organisms concerned, the lac-insect and its food-plant; the nature of the relations that exist between the insect and the plant, or between different varieties of insect and plant, the nature of the substances from which the insect elaborates its lac, the physiological process by which it performs this remarkable operation, the effect of climatic and other conditions on the plant, insect, and lac-production, and the methods of protecting either plant or insect from the many enemies that beset and injure them.

Although, as we have said, the information at our disposal on most points connected with the insects and "host"-trees they feed on is fragmentary, and a good deal of it untrustworthy, it may be permissible to draw attention to a few miscellaneous matters that are of biological and practical interest.

One may say that the produce of the lac-insect is as follows:—

(1) Lac, consisting of a complex of *resinous substances* and waxes, the amount of waxy matter being less than 10 per cent. There is also a little colouring matter present.

(2) *Lac-dye*, consisting of at least two dye-stuffs, and almost entirely concentrated in the body of the insect and its eggs or young.

(3) "Honey-dew", the insect's sugary excrement; of no commercial value.

These substances are all manufactured by the insect from the material it sucks up from its "host"-plant. The honey-dew is excreted, the lac-dye accumulated in the body and in the eggs, while the various components of "lac" are apparently elaborated in special secretory glands and exude like sweat from various parts of the body, the yield being specially abundant from the female during the period of gestation.

On these processes—probably on all of them—the nature of the insect's food, or the kind of plant on which it is living, has an influence in the sense that the lac produced by the same strain of lac insect from different plants will not be quite the same quality. It has indeed been thought that the part played by the insect is practically that of a strainer or filter—that the plant-juice is sucked up, some of its constituents absorbed and digested by the insect, and the rest excreted in the form of lac.

In that case the composition of lac from a given plant will depend directly on the composition of its "juice", and will probably vary a good deal with different plants. Personally we think there is no doubt that the other view is correct, that the insect "manufactures" the lac in its own body from raw materials that it gets from the plant-juice. The composition of the lac from a given plant will then depend only indirectly on the composition of its juice, and (as seems to be the case) will generally remain fairly constant whatever the plant from which its raw materials were derived. Whichever view may be the correct one, there is certainly some difference (especially in colour, to which the trade attaches much importance) in the lac from different plants, and moreover the insect apparently tends in time to develop different physiological characteristics according to the plant on which it is kept.

A list of the principal food-plants is given in Chapter II. The most important are:—

(1) The Kusum (*Schleichera trijuga*).

(2) The Ber (*Zizyphus Jujuba*).

(3) The Ghont (*Zizyphus xylopyrus*).

(4) The Palas or Dhak (*Butea frondosa*).

Kusum lac is specially light and clear in colour, and is more highly valued than that from any other tree. Moreover, it is generally accepted that brood from the Kusum tree will thrive on any other lac-bearing tree to which it may be transferred; but that the reverse is not the case, as insects from other trees will not live on transfer to the Kusum tree. An explanation generally current is that the Kusum tree has a harder and thicker bark than other trees and that the Kusum insect has thus developed a stronger and longer proboscis which is able easily to penetrate softer and thinner barks; whereas the proboscis of insects from other trees is unable to penetrate the Kusum bark. It is in the writers' opinion more probable that the failure of insects from other plants to live on Kusum, if indeed they do fail, is due to physiological causes rather than to any structural weakness.

In this connection it is interesting to find that when Kusum brood is transferred to the Palas tree, the first crop is known as "Bastard lac", and it is said that its properties are intermediate between those of Kusum and Palas lac, while subsequent crops approximate more and more to the Palas variety.

There are various statements and beliefs to be found regarding the relative facility with which different plants are colonizable by the lac insect, but they seem never to have been tested by any actual experimental enquiry, and there is reason to believe that at least some of them are mistaken. Thus lac-bearing trees still require to be classified in order of their suitability or unsuitability for promiscuous propagation, if any definite order does actually exist, so that the brood from any tree on the list might be successfully transferred to any other tree classified below it, though perhaps not to any tree classified above it. Of the four trees mentioned above, the correct order on this principle is stated to be:—

(1) Kusum.
(2) Ber.
(3) Ghont.
(4) Palas.

A further distinction, already referred to, between the Kusum and other trees considered as "hosts" for the lac insect, relates to the periods of swarming. On the Kusum tree the summer brood usually emerges during July-August and on other trees during June-July;

the winter brood on Kusum emerges during December-January, and on other trees during late October-December. There are, however, considerable local variations in these periods, some particulars of which have been recorded by Imms and Chatterjee. It is of great importance that the swarming periods should be carefully determined for each lac-growing area and for each important "host"-tree Imms and Chatterjee quote an exceptional case in which, in 1913, samples of stick-lac from the Kheri forest swarmed on February 22nd. A parallel instance was observed by Lindsay, when stick-lac that had been kept for some time in bags in the Rang Lal factory at Ranchi swarmed on exposure to the light Observation in the laboratory indicates that at certain stages the swarming larvæ are "positively heliotropic"; in other words, they go towards the light, *e.g.* of a sunny morning, and it may thus be possible to delay the swarming of brood-lac by keeping it in a light-tight receptacle. This might under certain circumstances be of considerable practical value in connection with the collection, storage, and transport of brood-lac from one locality to another.

Vague statements have appeared to the effect that in Mysore and Burma there are lac insects which breed three times in a year instead of twice. Whether this is the case or not remains to be seen, but it is interesting to note that lac from *Shorea Talura* in Bangalore, which originated from a swarm in the latter part of December, swarmed on April 21st in the laboratory at Dehra Dun, a remarkably early date. This seems to be the most definite evidence as yet available as to the existence or otherwise of this tri-voltine breed; but the possibility of getting three crops instead of two is certainly of interest.

It is from every point of view desirable that a comparative study of the different varieties of lac insect from different areas should be made in order to arrive at some definite knowledge of their hardiness, adaptability to particular host-plants, and lac-producing efficiency. The fact that we are still unable to say whether there is, or is not, a tri-voltine variety of an insect of such great commercial importance is an indication of the extent to which its general study has been neglected.

There is one particular side of its study—the physiological side—which has also been entirely neglected, perhaps on account

of its difficulty, although it is of very great practical importance. This question of physiology—namely, what is the nature of the transformation that goes on inside the insect's body—lies at the root of the whole matter When we have found out how the insect makes its lac and what raw materials it uses, we may begin to stimulate its production and control the quality of its produce; but until the physiological question is tackled, no confident advance in these and many other directions is possible, and this is the point on which attention should primarily be focussed in the event of biological research on lac being undertaken.

Another biological enquiry of much importance is that relating to the enemies, parasites and diseases of the lac insect and its food plants. In the case of the insect, there is a good foundation for this study in the work of Imms and Chatterjee, who have described some of its more important enemies. The most destructive of these are the caterpillars of three or four species of small moths of the genera *Eublemma*, *Hypatina* and *Holococera*, and a few small Hymenopterous (Chalcid) parasites. The Chalcid larvæ probably consume the bodies of the living lac insect, while the caterpillars of the moths (*Eublemma amabilis* being the most notorious) apparently consume both lac and insect, riddling the lac with their web-lined tunnels. Some of the Chalcids may also quite possibly be "hyper-parasites" of the caterpillars, and therefore beneficial

Among those qualified to judge there is complete agreement as to the seriousness of the loss occasioned by these insects, though its actual magnitude cannot yet be estimated. Imms, who has devoted considerable attention to their study, believes the loss to be very large, and urges the importance of a more detailed investigation with the object of checking their ravages. He suggests a scheme for determining whether the lac insect is the only insect that they victimize, or whether they have other hosts. The point is of prime importance in considering preventive measures, and an abstract of the scheme is given in the Appendix on "Research."

Ants are believed by some to do serious damage to lac, and they are very frequently seen running about on it in a manner which looks suspiciously predaceous. It is probable, however, that they are merely licking up the valueless "honey-dew", to which they are passionately attached; many other *Coccidæ* besides the lac insect are attended

by ants for the sake of their honey-dew, and there is no reason to suppose that ants are really responsible for any appreciable amount of damage. Imms gives a list of eleven species of ants that are often found associated with lac insects, but thinks it unlikely that they are of any importance as enemies.

At present no fungal or bacterial disease is known to attack the lac insect, a fact which encourages the hope that their future intensive cultivation under more completely domestic conditions, as in the case of the silk-worm, may not be a matter of exceptional risk or difficulty. The enemies and diseases of the many food-plants of lac are too numerous to be mentioned here, and no one of them can be considered of sufficient general importance to merit detailed treatment in a report of this kind. The last and perhaps at present the most important enemy of all, the human thief, hardly comes within the normal scope of this chapter, but it may be suggested that intensive cultivation of the insect under more nearly "domestic" conditions would probably be the simplest way of checking loss from theft.

CHAPTER II.

THE HOST-TREES OF THE LAC INSECT.

The relations between the lac insect and its host

This subject has up to the present time received practically no attention whatever. The authorities do not discuss it, or else dismiss it in a very few lines, although it is of the highest importance if lac is ever to be cultivated on scientific principles. If the host is to receive special treatment preparatory to inoculation with lac, or remedial treatment to hasten its recovery from the after-effects, it is obvious that the precise relations between the insect and the tree must be carefully studied.

If one compares a tree bearing lac with an uninfected neighbour of the same species, the first point noticed is that the former has lost considerably in vigour. The vegetative growth is poor, the canopy is small, the leaves are much fewer, while flowers and fruit are often absent; the new shoots are weak and thin and the tree generally presents a very unhealthy appearance. In fact, with certain species of tree, *e.g.*, Ghont, it has been noticed that repeated and heavy inoculations with lac eventually kill the tree altogether. The natural deduction from the above facts is that infection with lac is fraught with consequences injurious to the health of the tree. It would seem, therefore, that one of the aims of cultivation should be to maintain an equilibrium between the lac and the tree and not to over-infect or too frequently to infect the same host-tree, as this course will eventually destroy it. The only condition under which heavy infection is admissible is when the number of host-trees is sufficient to allow of a rotation for replacement or recovery and their regeneration is assured. This condition nowhere obtains at present in the main lac-growing areas.

Although the above theory, that lac is a disease of the host, is generally accepted as correct, Mr. S. Mahdihassan of Hyderabad (Deccan) has published a pamphlet in which he takes up an entirely different attitude. On this pamphlet Mr. F. M. Howlett has recorded the following opinion:—"Mr. Mahdihassan considers that the lac insect's normal function is a beneficent one, in that it thrives

only (or mainly) on plants more or less afflicted with "gummosis," a disease involving an abnormal growth of gum-producing bacteria in the tissues of the plant; the suctorial activities of the insect, by removing the gum and the bacteria that produce it, thus actually promote the welfare of the plant by reducing the disease.

"The more ordinary view, to which I confess I still adhere, is that a diseased condition of the plant is in no way essential to its successful colonization by lac insects, whose sensory, suctorial, digestive, and secretory apparatus has in the course of several million years become fitted to find, extract, and digestively deal with certain compounds that are normally present in the sap and cambial layer of many plants, the plants being, in the ordinary sense of the word, the insect's victims If the larval lac insect finds itself on a branch (whose bark is not too thick to pierce) of any plant whose juice suits its digestion, it will, I believe, attack it, even though the plant itself may be perfectly healthy and vigorous. It is generally believed that if the number of lac insects on a tree be large, their combined attack may kill the tree, just as does that of any other ordinary "pest". There is in short no reason as yet to attribute to the lac insect any beneficent rôle, or to doubt that its attack tends to hurt rather than help its "host" or victim. In other words, from the point of view of the tree the lac insect is a pest and not a physician, and no definite symbiotic tendency has yet been demonstrated

"In this connection it is also appropriate to point out that our comprehensive ignorance of the insect's physiology does not justify Mr. Mahdihassan's assumption that lac is produced from the water-soluble gums present in the plant. Lac itself is far from being a simple substance, but is a complex of some half a dozen by no means simple compounds, and at least some of these compounds may very probably be derived from fatty acids and essential oils or terpenes rather than from gum. Until therefore the digestive and secretory physiology of the insect has been investigated, it is unprofitable to make any positive statements as to the genesis of lac."

A fact which at first sight seems somewhat remarkable is that the lac insect is able to pass through two generations in a single growing season of the host, for it seems *a priori* unlikely that the peculiar conditions necessary for the welfare of an insect with so involved a life-history as the lac insect could recur at two different

periods in a single growing season of the host. The apparent explanation of this fact (though it has admittedly not been proved) is that in India most trees, if they have not two growing seasons in the year, have at any rate two periods in the growing season when their vegetative activity is much greater than usual. These periods are in the hot weather preceding the rainy season, and again in the autumn immediately after the rains. Most trees produce long shoots at both these periods and the flowering time is frequently at one or other of them. With a view to further consideration and enquiry it is here suggested that the period of intense lac production immediately following the impregnation of the female lac insect coincides with or is in some way dependent on the corresponding period of vegetative activity of the host; and that the reason why the winter brood takes so long to mature, and why a comparatively small amount of lac is produced before March, is that the host is then inactive and its branches contain very little sap before that month. Should this theory be found correct it will provide a simple explanation of the fact that in the autumn brood the male undergoes his metamorphosis in about one month while in the spring brood he takes $3\frac{1}{2}$ months; on the assumptions, firstly, that he is waiting for the period of vegetative activity on the part of the host so that the abundant supply of food required by the female during the first part of the period of gestation may be forthcoming, and secondly that lac production by the female is a measure of food absorption.

The principal host-trees.

The lac insect appears to be able to sustain life for a time at least on almost any tree or shrub on which it is placed, but it is only on a few that it can thrive well and reproduce itself. Very much smaller is the number of trees and shrubs on which the cultivation of lac is of real commercial importance. The following are the more important species:—

Name used in this note.	Systematic name.	Bihar and Orissa.	Central Provinces	United Provinces	Burma.	Assam.	Punjab.	Bombay.	Madras.
Palas ...	*Butea frondosa*, Roxb	Paras, Faras.	Cheola, Dhak, Palas.	Dhak, Palas	Pauk	Lahokung...	Palas .	Palas, Khakari	Parasa, Moduga.
Kusum ...	*Schleichera trijuga*, Willd.	Kusum	Kusum	Kusum	Gyo		Kusumb, Samna	Kusum, Peduman	Pava.
Ber.	*Zizyphus Jujuba*, Lamk.	Kul, Kuli, Ber	Ber, Ringi (Gond).	Ber ..	Zi		Ber	Ber, Jangri (Sind)	Elandap, Regu.
Ghont ...	*Zizyphus xylopyrus*, Willd		Ghont, Ghatber	Kathber, Bhander, Chitena			..	Goti ...	Kuttai
Pipal ...	*Ficus religiosa*, Linn.	Pipul	Pipal .	Pipal .	Nyaung-bandi	Borbur	Pipal	Pipur, Sindi Pimpal	Arasa.
Babul .	*Acacia arabica*, Willd.	Babul .	Babul ..	Babul	.	...	Kikar .	Babar (Sind)	Tuma, Gobli
Arhar . .	*Cajanus indicus*, Spreng	Arhar, Rahar.	Arhar, Tur	Arhar, Tuar	Pesingon...	Mirimah, Garomah	Arhar, Tohar	Tura ...	Tuvarai.

The following are of less importance at present but are worthy of consideration and extended trial:—

Ficus spp. infectoria, glomerata, Rumphii, etc.
Albizzia Lebbek and other Albizzia species.
Acacia Catechu and other Acacia species.
Butea superba.
Dalbergia latifolia, paniculata and other species.
Mangifera indica, the mango tree.
Ougeinia dalbergioides.
Pithecolobium species.
Shorea spp. Talura, obtusa.
Tamarix gallica.
Prosopis spicigera.
Spatholobus Roxburghii.
Pentacme suavis.
Dipterocarpus tuberculatus.

Stebbing gives a long list of other trees on which lac will grow, but they are of little commercial interest.

Sylvicultural notes of the principal species of host-tree.

Palas.—The Palas grows wild over the greater part of the plains of India and is usually gregarious on good soils. It occurs in typical mixed forest on poor soils but is more a tree of the open country and scrub jungle of which it is frequently the principal species. It is a moderate-sized deciduous tree, frequently with a crooked irregular stem. A red astringent gum exudes when incisions are made in the bark. The leaves are in threes, but shoots with single leaves may sometimes be found. The flowers, which appear in late March and April, are red (occasionally yellow), and the tree is often popularly known as "flame of the forest". The fruit is a bean, ripening in the hot weather. The leaves follow the flowers and fall in February, so that the tree is bare from February to April. The wood is used little for timber, but frequently for fuel, although the tree is now generally conserved for the cultivation of lac. It is very easy to propagate from seed and will grow rapidly to 18 inches girth and 20 feet high in 15 years (10 years if irrigated). It coppices very well, is frost-hardy and drought-hardy and rarely browsed even by goats. The formation of regular Palas plantations, though easy, is not recommended, as Ber is equally easy to establish and will give

better results. Palas responds well to pruning and repeated pruning does not appear to affect materially its power of throwing out pollard shoots.

Kusum.—A large deciduous tree found in the sub-Himalayan tract from the Sutlej eastwards, in the southern C. P., Chota Nagpur, Orissa and Burma. It is found elsewhere, but is not common. It is never gregarious, but occurs scattered in high forest and occasionally in groups of a few trees. It seems to prefer a high altitude and to grow best at about 2,000 feet, and is frequently found by the side of rivers and nalas, but cannot stand water-logging and, once established, is drought-hardy. In dry deciduous forests it stands out as a conspicuous object during the hot weather months on account of its fresh green foliage. Kusum is decidedly slow in growth, coppices poorly and pollards less vigorously than other lac-growing species. The old leaves are shed in February and the new appear in March-April, purple at first, changing to a fresh light green. The flowers follow the leaves immediately and the fruit ripens in the hot season. Thus in habit it closely resembles *Shorea robusta* (Sal) with which it is frequently found mixed. It may be raised easily from seed or cuttings, but in early years is very slow in growth. In general appearance it closely resembles *Bassia latifolia* (Mohwa), though it is readily distinguished by its lighter bark and characteristic leaf formation—no terminal leaflet, but generally three on each side.

Kusum produces a finer quality and larger individual crop than any other known lac-bearing species, but its solitary habit and preference for heavy jungle increase the cost of cultivation and discourage its more extensive use as a lac host. Lac cultivators profess to be able to distinguish several varieties. In Raipur there are said to be two varieties, one with a small curly leaf and the other with large leaves. Only as a last resort will the cultivator infect the curly leaved variety; his explanation is that the sap is acrid and that the insects may die on attachment In other places cultivators will distinguish as many as four varieties, but always by leaf variations. It is probably merely a question of locality, but requires investigation

Kusum is affected very strongly by the attacks of the lac insect and requires several years to recover its vitality, so that at least a three years' rotation is necessary.

Wherever Kusum exists in sufficient quantities its infection with lac is recommended, but on account of its slow growth private

individuals will rarely care to undertake the formation of plantations. Kusum sown fifteen years ago along nala banks in Raipur are still straggling bushes, unfit for lac cultivation. The experiment is, however, hardly conclusive as, once sown, the trees received no further attention. Kusum wood is hard, with close and twisted grain, heavy, tough and strong, and its heart-wood is reddish. The fruit is of some commercial importance as it yields a macassar oil.

Ber.—Ber is the wild (but also cultivated) edible plum tree found almost anywhere in India. It is a medium-sized evergreen tree, grows well in poor soils, but much better in good manured soils. Its branches have a tendency to droop and are covered with thorns. The leaves are oval and about 1"—1½" long, the young foliage appears in March-April while the old leaves are dropping. The flowering period varies, but in the lac area generally follows the new leaves immediately. The fruit ripens in December-January. It has been very widely cultivated in the past in gardens and around homesteads for the sake of its fruit, but in lac-growing districts such as Manbhum and the Sonthal Parganas, the conservation for fruit has almost entirely given place to the cultivation of lac. If it gets plenty of animal manure its growth is vigorous and it gives good crops of lac which can be cultivated on a twelve months' rotation.

The propagation of Ber from seed is easy, growth in favourable localities is rapid and the tree is fit to inoculate with lac in five to ten years' time. It coppices well and according to local traditions must be coppiced in early youth as seedling trees will not bear lac. There is, however, no scientific confirmation of this theory.

On account of the ease with which this tree can be propagated, the good quality of its lac crops and its alternative value as a fruit producer, it is very popular as a lac host. It is gradually replacing Palas and is the tree to be recommended to anyone desirous of raising plantations with the object of cultivating lac.

Ghont.—This species, which appears to replace Ber in rocky hill tracts, is to be found all over India. Usually scattered in mixed types of forest, it appears to reach its optimum in a small area including the whole of Damoh district (C. P.) and adjoining areas in Saugor, Jubbulpore and Narsingpur districts, and in several of the Central India States. Here it is practically gregarious. It closely resembles Ber in habit, but is straggling in growth and inclined to

be less thorny. It appears to have developed on parallel lines with Ber but has more xerophytic adaptations. It seems to prefer a well-drained rocky soil and has been seen growing with some vigour out of sheet rock.

It coppices and pollards well and is a very suitable host for lac wherever it exists naturally; but it appears to feel the effects of lac cultivation somewhat severely, and therefore care must be taken, until knowledge is more definite, not to over-infect it. It is probable that a two years' rotation will be found suitable for lac cultivation.

Pipal.—Pipal is a large glabrous tree, indigenous to the sub-Himalayan tract and to the Pegu Yoma. It is sacred to both Hindus and Buddhists and is therefore cultivated throughout India; it is commonly found growing in the interstices of masonry work on which it has a destructive effect. It can be raised from seed or cuttings and is of rapid growth. It is leafless for a short period in early summer, and usually bears fruit in the hot weather with occasionally (in the C. P.) a second crop in October-November.

The lac produced is of good colour but very poor quality and there is considerable religious prejudice among Hindus against the cultivation of lac on it, so that its use as a lac host on a commercial scale can hardly be recommended.

Babul.—The Babul is a moderate-sized tree cultivated throughout India, indigenous to Sind and the northern Deccan, gregarious in habit, evergreen, fast-growing. Its foliage first appears in the hot weather, and both foliage and pods are excellent fodder. A gum exudes from incisions made in the bark. Information as to the growth of this tree in the Deccan is summarized by Rao Bahadur S. Srinivasalu Nayadu in a paper read at the Nagpur Forest Conference in 1908. It flowers from July onwards and the fruit ripens in February. The seed has a hard testa or outer covering and germinates with difficulty unless specially prepared. The best results are obtained from the seed rejected by goats fed on the pods; it is then easy to propagate and in Berar grows to 12 or 15 feet in 10 years. It coppices badly.

Babul can boast a very large number of varieties. In Berar three are recognized and the fact that Babul brood lac cannot be propagated in other parts of India than Sind is probably due to the existence there of local varieties of Babul as well as possibly to local

varieties of the lac insect and to special climatic conditions. This, however, requires investigation.

Arhar.—Arhar is a field crop cultivated widely throughout India. Recently a field of Arhar plentifully infected with lac was seen in the Palamau district not far from Daltonganj. The brood had been taken from neighbouring Palas trees. The cultivator estimated that the lac crop would be ready to collect shortly before the Arhar itself was finally cut and harvested. Only in Assam, however, does Arhar live for a sufficiently long period to allow of its infection on a commercial scale with lac. There it is grown in freshly-burnt (or "jhumed") jungle soil, and survives long enough to bear two crops of lac. Infection is carried on from one Arhar crop to another. The possibility of introducing a longer-lived variety of Arhar, as a lac host, in India proper, would undoubtedly be worth investigation. Although the quality of the lac is not particularly good, the yield is plentiful and the incrustations are thick and well-developed.

CHAPTER III.

DISTRIBUTION.

Tachardia lacca is found distributed widely throughout India and extends into the adjacent countries on its eastern and north-eastern borders. It occurs in Bihar and Orissa, Bengal, Assam, Bhutan, Thibet, Nepal, the United Provinces, the Punjab, Bombay (including Sind), Central India, the Central Provinces and Berar, Hyderabad (Deccan), Mysore, Madras, Travancore, Burma, China, French Indo-China, Siam and the Straits Settlements. Its general distribution is therefore wide, but it is only grown on a commercially important scale in a few rather restricted areas.

The main area includes the whole of Chota Nagpur, Orissa, the north-eastern half of the Central Provinces including all the Chattisgarh Feudatory States, Bundelkhand and Baghelkhand; it extends into parts of the Bankura, Birbhum, Murshidabad and Malda districts of Bengal and into that part of the Mirzapur district (United Provinces) which lies south of the Sone river. The bulk of the world's lac is grown within this area. The other important areas are :—

(1) *Sind.*—A narrow strip on both sides of the Indus in Hyderabad and Karachi districts

(2) *The Punjab.*—The Una Tahsil of Hoshiarpur district.

(3) *Assam.*—The Khasi and Jaintia Hills, the Garo Hills, Kamrup and Nowgong districts, with extensions into Thibet.

(4) *Burma.*—The Arakan Yomas, many districts of Upper Burma, the Northern and Southern Shan States and Karenni. This area extends into Siam, French Indo-China and China.

The following figures show the relative importance of these areas by outturn :—

Area.	Average total annual crop in maunds	Percentage of total outturn.
	Mds.	
Main area	1,003,500	86 6
Sind	26,000	2'2
The Punjab	33,000	2 9
Assam	65,000	3'0
Burma, etc.... ..	62,000	5'3
Total ...	1,159,500	100 0

The Burma figures include an average of 7,000 maunds annually from French Indo-China and 16,000 from Siam, both of which are actually exported to France, and 9,000 from the Straits Settlements, usually exported to India.

The commercial importance of the subsidiary areas is even less than the above figures show, as all the high grade lacs are grown in the main area. The lac from Assam and Burma is hardly fit for the manufacture of even the low grades of Orange shellac and is commonly used for Garnet lac. Sind lac is quite good enough for TN and Punjab lac for better grades. There seems to be some indication that the further one goes from the main area, the worse is the quality of the lac.

An attempt has been made by means of the map attached to this report, to show the distribution of lac in the districts and Native States of the main area of production. There is no pretension that this map is accurate in detail. No attempt has been made to show the relative intensity of cultivation but this may well be judged by the occurrence of the large and small markets. The principal species of host-trees are indicated, together with the markets and manufacturing centres. Further details of distribution will be found in the local notes at the end of the report.

From the above account it is clear that India has a virtual monopoly of lac. Attempts have been made to transfer brood from India to Japan and parts of Africa, but, it is believed, with no success.

From the point of view of India it would be a mistake to encourage any repetition of these attempts as success might endanger an industry which now gives employment to thousands of regular workmen in this country and increases the earnings of hundreds of thousands of the poorer cultivators. India is more than capable of supplying all the world's shellac requirements for many years to come, and the extension of the industry, called for by the present strength of the foreign demand, may well take place on an adequate scale within her own borders. The boom in shellac during 1919-20 has aroused interest in lac throughout India and the result seems likely to be a considerable extension of cultivators. Later chapters show that none of the districts which now produce the largest quantities of lac are, in any sense of the term, intensively cultivated. Where Government action is taken to increase the supply, its object will be more easily fulfilled by systematising and intensifying cultivation in areas where success is assured, than in attempting to extend it to areas where it is not already grown commercially.

In Chapter I the climatic factors which influence the distribution of the lac insect have already been discussed. From the commercial point of view one other factor is of supreme importance, namely the quality and extent of communications, and in particular railways. A glance at the map of the main area shows that the area is wholly situated within the districts served by the Bengal-Nagpur and East Indian Railways, south of the Jumna and Ganges.

The lac markets are mostly situated on railways and the proximity ofrailways has thus a very stimulating effect on production. An excellent example is afforded by the Chattisgarh Feudatory States. The States producing the largest quantities of stick-lac are Korea, Raigarh and Kanker. These are small States and the only reason for their large production is their proximity to the markets at Pendra, Raigarh and Dhamtari, respectively. Conversely Orissa and Bastar, lying between the two B. N. R. main lines, form without exception the largest area in India unserved by railways; and, except for the Rajputana desert, the Chota Nagpur-Surguja area lying between the B. N. R. line and the E. I. R. Grand Chord is the next largest. Both these tracts are of the greatest importance, not only because they form part of the main lac area, but further because they contain large numbers of Kusum trees, hitherto entirely neglected. The

opening up of these tracts by means of railways will have an immediate effect on stick-lac production. The only project which seems up to the present to have taken definite form is the Raipur-Vizianagram chord, which should result in the development of very important Kusum areas in Raipur, Patna and Kalahandi.

of much practical importance, though *sona phunki* may be expected to be freer of dye than *gada phunki*.

Existing methods of cultivation.

In its primitive stages the industry involved no artificial measures of cultivation and consisted merely in collecting what lac grew wild and trusting to Nature to arrange for subsequent crops. What actually happened was that some small quantity of lac was left on the trees; and by rapid reproduction in a few years' time, sufficient insects matured to give another fair-sized crop. This method is still common in Burma and in areas where lac occurs spasmodically, but is not now of sufficient importance to merit more than passing reference.

The modern method, common all over the lac-growing areas, is to leave untouched the upper one-sixth or one-third of the crop when the lac is harvested. Unfortunately, however, when the larvæ emerge on the upper branches, the lower branches are bare of all leaves and succulent shoots, which were broken off in collecting the bulk of the crop for the market; and, moreover, the vigour of the tree has been reduced by the recent crop. The result is that the emerging larvæ find few suitable places for attachment and the greater number die. At the next swarming season there will be, on the top one-third of the tree, a small but not a very healthy brood, as the tree will be lacking in vigour and the sap will be scanty and poor The lower two-thirds of the tree will show a few sickly. thin, pollard shoots This brood also, on emergence, will occupy any suitable spots on the top branches, but the majority will fall on or through the pollard shoots below, where only comparatively few will succeed in attaching themselves.

A better method is now practised in parts of Manbhum, Ranchi and other Chota Nagpur districts and is extending into the Central Provinces. It is more common on Ber trees growing round homesteads than in the forest The greater part of the lac is cut *ari*, but a proportion of the trees, often one-tenth, is reserved for brood-lac, and when the larvæ are ready to emerge the lac is removed and attached to trees which were not infected during the previous season. This is an excellent method in theory, but is very rarely properly carried out. The maximum secretion of lac is not attained until about a month before the swarming period and the cultivator is tempted to collect as much as possible, as early as possible, with a view to shorten the labour of watching the trees and minimize the risk of theft; or else

to secure the top of the market before other cultivators unload. The result of this improvidence is that, when the swarming period comes round, he too often finds that he has neither the brood nor the money to buy it, and either leaves his trees uninfected or mortgages his future crop to a money-lender in order to secure funds for the purchase of fresh brood, which is always sold at exorbitant rates during this period. His trees remain too lightly infected, and he may find the next crop hardly worth gathering and will have to leave it on the tree so that the subsequent crop may be big. Further, his choice of trees for infection is not carefully or intelligently made, and the trees never receive any special pruning prior to inoculation, however desirable this may be. Finally, when prices are low, the brood will be allowed almost to die out and brood-lac may be practically unprocurable when prices rise again.

The Esociet Company (W. A. Fraymouth, Esq., F.C.S., Managing Director) of Maihar, C.I., a company which aims at developing the resources of the States of Central India, employs the following method. It has adopted what is really the first principle of lac cultivation, namely, that no lac should be removed from the forest until it has surrendered its swarm of larvæ. The principal lac-bearing tree in this area is the Ghont. As labour is not so difficult to obtain during the winter season as during the rains, the Esociet rely chiefly on the Katki or winter crop for their market crop of lac but take care not to collect the *phunki* lac until the requisite number of larvæ have swarmed to provide for the Baisakhi or summer crop. As soon as the summer brood shows signs of being ready to swarm, labourers are sent into the forest to cut off all the branches which carry lac. These are laid on other trees not yet infected, on which the larvæ are allowed to swarm. No other pruning is done. When the larvæ have swarmed the *phunki* lac is collected. The chief defect of this method, which is a great advance on those previously discussed, is lack of concentration. The whole area under cultivation has to be regularly guarded to prevent theft, and the collection of the *phunki* lac is rendered very difficult by the indiscriminate way in which it is scattered throughout the forest. The methods employed in the Damoh Government Forests are similar to the above and it is probable that both have the same origin as the Esociet Company leased the Damoh Forests in 1915—17.

On the face of it, the system seems sound, but the study of the life-history of the insect reveals its defects and suggests scope for improvement. The position is as follows: The female insects remain attached to the branches throughout their life-period of about six months. During this period, new succulent twigs have sprouted on the tips of the branches on which the insects have secreted lac. The natural instinct of the new brood is to pass over the mother lac from which they emerge and to progress towards the extremities of the branches in their search for the fresh young twigs. Branches and twigs cross and re-cross occasionally, and some larvæ use these natural bridges to find homes on other branches. But the greater number undoubtedly settle on the fresh shoots at the end of the parent branches, and these are, of course, destroyed when the parent branch is cut in collecting the cold weather *phunki* crop by the Damoh method. It is not argued that the entire crop is thereby destroyed; if so the lac industry would have died out in the Damoh Government Forests, whereas it is increasing. But it is an undoubted fact that the system does not make full use of the Katki crop for propagation, and it is partly for this reason (in addition to those already mentioned) that the Baisakhi crop cannot be used as a commercial crop. A possible alternative would be to break off the *phunki* lac from the twig, leaving the latter unscathed with the new brood on its extremities. But this procedure would require much delicacy of touch, would mean the loss of much good *phunki* lac left adhering to the tree, and would be absolutely impossible of practical execution in present labour conditions on any extensive scale.

Labour conditions

Of the lac now grown, only about 2 per cent. comes from Government Forests and perhaps 5 per cent. from areas leased by large cultivators or contractors. The rest is entirely in the hands of uneducated villagers, cultivating a few trees each. The higher caste Hindus are prejudiced against the industry on the ground that it involves taking the life of the insect. Most of the *lactora* or lac-growing castes are aboriginal, but not all aboriginals will undertake lac cultivation. The wilder the districts, the stronger is this caste prejudice. While in the Manbhum, Murshidabad and Malda districts it has largely disappeared, it is still quite strong in parts of the Central Provinces, where only one or two of the many septs of Gonds will engage

in it. The same prejudices affect the manufacture and handling of shellac, but to nothing like the same extent. There is no doubt that, as the material profits to be made from lac cultivation are realized, the prejudice against it is gradually dying out.

A serious obstacle to the extension of lac cultivation is the risk of petty theft. When the price of clean stick-lac is a hundred rupees a maund and over, as it was in early 1920, there is every incentive to an unscrupulous passer-by to steal some lac-bearing twigs which can be hidden on his person and subsequently sold for a few rupees. Theft of lac when the crop is maturing is the commonest petty crime in the lac districts, and it is so prevalent that in some cases police reports of theft have been of material assistance in ascertaining the distribution of cultivation. Fear of theft is the principal reason why most lac is cut *ari* and as little as possible, or none at all, is retained for brood purposes. The crops mature a month before the larvæ emerge, and if the cultivator keeps his lac for brood he must watch it for an extra month for no definite gain that he can see and with every prospect of having it stolen. In the Damoh district of the Central Provinces, where lac is cultivated on a large scale by the Forest Department, special rules have had to be issued under section 41 of the Indian Forest Act to protect lac in transit; all such lac must be covered by a pass from the grower, which is exchanged for an official pass at the nearest Forest Revenue Station. These rules should have a deterrent effect by making theft more difficult, but will by no means obviate the necessity of watching the crops for at least three months before the larvæ swarm. With extended cultivation the only safeguards are constant patrol and effective supervision.

Costs of production

In view of the widely varying circumstances in which lac is cultivated, it is not easy to furnish a general estimate of the cost of production. The following particulars have been furnished by the Settlement Officer of Chota Nagpur and may be taken as typical. The rent charged by a zamindar will vary with the species of tree to be infected. The actual sum is usually not fixed until after inspection of the crop and varies with its quality, from one-half to three annas each in the case of Palas trees and from two to eight annas each in the case of Kusum trees, although higher rates up to one or even two rupees are

known to have been charged for large Kusum trees heavily infected with lac. If the lac crop should fail no charge is made, and quarter or half rents will be taken for poor crops.

The cost of brood-lac for infection will naturally vary with the condition of the market and the circumstances of the case. In normal years a bundle of brood-lac sufficient to infect four fresh trees would cost one rupee; in addition the cultivator frequently introduces each year a small quantity of fresh brood-lac, which he may obtain either by purchase or by transfer from other trees settled with him. Two annas for each tree is perhaps a fair estimate of the average annual cost of infection in normal times, although prices have risen during the recent boom.

Each cultivator can infect from eight to ten trees in a full working day and for this the cost may be taken at two annas. There is also the cost of guarding the lac during its development. This charge, like that immediately preceding, is difficult to work out as it represents not the market cost of labour, but the value to the labourer of employment during his spare time, it may be taken at Rs 2 per mensem for each block of 100 trees The collection of the lac and its rough cleaning by the removal of superfluous twigs, etc., represents a full day's work for each tree and this also may be taken at two annas.

The total cost of cultivating a good crop of 100 Palas trees may, therefore, be taken at —

	Rs.	a	p
Rent, raiyat	12	8	0
Brood-lac	12	8	0
Cost of applying brood-lac	1	4	0
Cost of guarding lac for 4 months	8	0	0
Cost of harvesting	12	8	0
The total cost is thus	46	12	0

Against this expenditure the raiyat may expect to get a return of say two seers or four pounds of clean or *biuli* lac from each tree; that is to say, from 100 trees 5 maunds, for which he will obtain during a normal year from a minimum of Rs. 10 to a maximum of Rs 20 per maund. During years when prices are abnormally high he may of course be able to secure as much as Rs. 40 or even Rs. 60 per maund for the best qualities, and such windfalls are remembered and their effect lasts for a considerable time as a

stimulus to production. In an average year he cannot hope for a return of much over Rs. 15 a maund, giving him a fair profit on the whole transaction. He will also obtain a small return from the sale of the *phunki* lac from which the brood has swarmed at the time of infection.

General

The shellac market is one of the most unstable and prices frequently fluctuate between wide levels. The prices of stick-lac follow the shellac prices and in the past, often for several successive seasons, cultivation has barely repaid the labour expended on it. The cultivator is generally uneducated and improvident. When prices rise trees are stripped of lac, brood-lac becomes difficult to obtain, and, if obtainable at all, secures a high premium. In order to get brood-lac, the cultivator will involve himself with a money-lender, and as the latter seizes most of the profits, the cultivator again loses interest. Co-operation is an obvious remedy and with close supervision should have excellent results. An alternative remedy is for Government and the big landholders to take steps to ensure ample supplies of brood-lac against seasons when it is scarce.

CHAPTER V.

SUGGESTIONS FOR IMPROVED METHODS OF CULTIVATION.

Among the desiderata for scientific methods of cultivation are a thorough knowledge of the life-history and habits of the lac insect and its hosts and of the effects of climate and locality upon them, and effective safeguards against the attacks of enemies. Our present meagre knowledge on these subjects has been summarized in previous chapters of this report. There is no pretension that the following method of cultivation is the best. It is the result of personal observation of existing methods and attempts to avoid their defects. It has not yet been put to any practical test, and will probably require modification, perhaps considerable modifications, to meet the requirements of different localities with varying conditions

Locality

The requisite climatic conditions have been described in Chapter I. Subject to these, the ideal area for cultivation is one in which as large a number as possible of well-developed and vigorous lac-bearing trees are available. Small and decrepit trees should be avoided as they are liable to be killed even by a single infection with lac. Old trees should be felled and their places taken by seedlings or coppice shoots.

The best lac is produced on the Kusum tree and, were other conditions equal, every one would grow Kusum lac. Kusum is, however, not a gregarious species; it is generally found scattered through forests and its cultivation is difficult. Palas is a common tree, frequently gregarious, especially in open grazing grounds near habitations. It is, therefore, often preferred. Ber is becoming more and more popular. Though not indigenous to all lac-growing districts, it has been widely planted for the sake of its fruit. Moreover it is a hardy tree and produces lac in quantity and of good colour and high quality. Ghont, where it occurs naturally, is to be strongly recommended, especially in Damoh and neighbouring districts where it grows almost gregariously over large areas of forest. Pipal and Banyan are not recommended. Though of good colour the lac is of poor quality; the trees are not gregarious and there is considerable

religious feeling among Hindus against their infection with lac. Babul is the most important tree in Sind, but lac has not been successfully cultivated on it in other parts of India. Arhar is successfully used as a host-plant for lac in Assam but its success in India proper remains to be established. The lac produced on Arhar in Assam forms a fine heavy incrustation ; but unfortunately the colour is dark and the general quality poor. It is more suitable for the manufacture of garnet lac than of TN. In other localities with special conditions other species will be found suitable, *e.g.*, *Shorea Talura* in Mysore.

Rotation.

With lac so valuable a product, so tempting to thieves and requiring a comparatively large labour supply for its propagation and collection, concentration must be the key-note to cultivation. A heavy lac crop, however, impairs the vitality of the trees and a definite rotation of coupes in a definite cropping series should be fixed with a view to giving them a period of rest. The terms cropping series and coupe are used for want of better, and will be clearly understood by all engaged in forest work. The cropping series will be the unit and its size should be such that it can be watched by one lac watcher or, where continual watching is required, by one series of reliefs. For convenience of control it will be found best to keep the cropping series in Government Forests fairly large, and gangs of watchers may be necessary. No series, however, should be so large that parts of it are more than a few miles from a central point of control

The rotation will depend chiefly on the species of the host, modified by locality, soil and climate. No research work has been done to find the correct rotations, but the following are suggested. If experience shows them to be either too short or too long, there will be no difficulty in making the necessary alterations :—

Kusum	3 years	6 coupes.
Ber	1 year	2 coupes, if on good soil.
Ghont	2 years	4 coupes.
Palas	2 years	4 coupes, possibly 1½ years only.

This means that for Kusum, for example, the area will be divided into six half-yearly coupes and each coupe will bear a crop for

one-half year and rest for 2½ years, when it will again be infected. On poor soils the one year rotation for Ber will probably have to be lengthened, though C. S Misra (Pusa Bulletin No. 28, 1912, Cultivation of Lac in the plains of India) states that successive crops have been obtained from it at Pusa for six years. Ber is, however, usually found on good soils or near habitations where it gets manured and tends to be vigorous.

Pruning

When operations begin, pruning will be necessary in order to provide the maximum number of young succulent shoots for the swarming larvæ. The periods of pruning are those when the growth of the host-tree is at its minimum. Most trees cease to grow for a time during the winter, and in many places February is an excellent time for pruning in preparation for the subsequent summer brood in July. For the winter infection in October-November (December-January for Kusum) pruning in July and early August will probably interfere least with the growth of the tree. It may be found possible to prune in February for lac inoculation in the following winter, but this is a matter for experiment Misra (loc. cit.) should be consulted by lac cultivators and much assistance has been taken from him in writing this chapter.

Sharp, heavy-bladed knives only should be used in all lac work. The axe should never be used as it does not give a clean cut, tends to strip the bark and frequently results in serious damage to the tree. It is very likely that a large-sized pair of rose-growers' pruning shears would be found useful in lac cultivation, specially the recently advertised patterns with a draw-cut. Vigorous trees should be lightly pruned, old and decrepit trees heavily pruned. If vigorous young trees are heavily pruned the resulting pollard shoots will be fewer than with light pruning, will present a much smaller area for the lac insect and may become rapidly suberised towards their base, and unfit for inoculation. Misra advises dressing all pruned stumps with coal-tar or cow-dung. This is advisable but will only be possible where an ample labour supply is assured.

During the first rotation almost every tree will have to be pruned. In subsequent rotations it is hoped that the removal of the lac-bearing twigs will be sufficient. In fact the criterion of a correct rotation should be that the trees in a coupe become, by recovery of their vigour,

automatically in a condition for re-infection as their turn comes round. Trees or parts of trees where infection fails will have to be re-pruned in the second rotation.

Infection

Before commencing to infect his trees, the cultivator must have ascertained correctly the times of emergence of the insect. These vary from district to district and with the species of the host, and the only way to discover them is by personal observation or by local enquiry. The swarming in any particular district is regular almost within a few days, but the winter swarm tends to be delayed by late rains and accelerated if the monsoon is short. Similarly a damp hot weather tends to delay the summer swarming.

About three weeks or a month before swarming the insect loses its white filaments and orange spots appear above each mother cell. At this time the mother insect ceases to feed and all her energies are taken up with the development of the coming brood. The appearance of the orange spots is a safe indication that she has reached this stage and will suffer no harm if her food supply is stopped. All the brood-lac required for purposes of propagation should now be gathered, care being taken to select only healthy and vigorous lac for this purpose. Any lac which appears to be full of predators should be rejected. The twigs should be cut into lengths of eight inches to one foot and stored until required in a moderate temperature and kept well ventilated. As the time of emergence approaches there is no need to store newly collected brood-lac, but it may be put out immediately on the trees prepared for inoculation. All twigs not bearing any lac should be cut off.

Several methods may be employed for infecting trees. The ideal is that which resembles natural conditions most, namely to wedge and tie the stick of brood-lac between two twigs to be infected, so that each of its two extremities touches a twig. The emerging larvæ can then walk directly from either end of the brood stick on to their new home. This method is, however, far too laborious for practical purposes. The commonest method is to tie several sticks of brood-lac loosely with straw to a branch of the tree immediately below the point from which a group of pollard shoots originates. The actual tying of the brood to the tree can frequently be dispensed with by placing the brood sticks in among the bases of a

number of pollard shoots. Misra recommends the use of small bamboo receptacles (costing 12 annas per hundred) fully described by him. These are filled with sticks of brood-lac and tied to the tree immediately below the points of infection. The advantage of the use of these receptacles is that they can be made and filled at a central depôt, are quickly put out on the trees and after infection can be rapidly collected. An important problem which can only be solved by practical experience is how to avoid over-infecting the trees and how to use, at each point of infection, the correct amount of brood-lac and no more. With cultivation on a small scale the brood can be removed when the trees are sufficiently infected, but in large scale work this is impossible and the amount of brood required can only be estimated.

Scheme of operations

As soon as the infection of the new coupe is satisfactorily completed, every bit of lac (now *phunki*) can be removed from the old coupe and sold; as also the lac fastened to the new coupe, when the brood has swarmed.

The work in a Kusum area during the first rotation will be as follows, the cropping series having been divided into six coupes numbered I, II, III, IV, V, VI :—

February 1920	..	Prune all trees in Coupe I.
July 1920	...	Collect brood-lac and infect trees in Coupe I
August 1920	...	Collect *phunki* brood lac in Coupe I and prune trees in Coupe II.
Dec 1920, Jan 1921	...	Collect brood-lac from Coupe I and infect in Coupe II.
January 1921	...	Completely remove all lac from Coupe I and collect the *phunki* lac in Coupe II
February 1921	.	Prune trees in Coupe III.
July 1921	...	Collect brood-lac from Coupe II and infect in Coupe III
August 1921	...	Completely remove all lac from Coupe II and collect *phunki* lac in Coupe III and prune in Coupe IV.
Dec. 1921, Jan 1922	..	Collect brood-lac from Coupe III and infect in Coupe IV, completely remove all lac from Coupe III,

and so on.

As the lac cultivator will have to keep a careful watch against theft during the months late April, May, June, and again in late September, October, November, it is clear that lac cultivation is practically a whole-time employment with slack periods (where Kusum is the host) in March-April and again in September. Where other trees are hosts the slack periods will be rather earlier in the year.

Costs.

Mr. C. A. Malcolm, Deputy Conservator of Forests, Saugor Division, has kindly supplied statistics showing the cost of lac cultivation on Ghont trees in that division under the Damoh system. On these the following are based. A well-stocked area should contain at least 40 trees per acre. Assuming a coupe of 300 acres or 12,000 trees, two lac guards will be required to supervise the work and a quarter share of the services of an Overseer. Omitting all cost of brood-lac, which will be obtained from the previous coupe, the cost for one cropping series, taking an average of six months' work, is as follows. The Overseer draws Rs. 25 per mensem but can look after four series. Six months' pay is Rs 150 of which Rs. 37-8-0 is debitable against each felling series. Two guards on Rs. 12 each for six months, Rs. 144. Each tree on an average will require infection in say 10 places. Coolies working in pairs and collecting their own brood can fix at least 150 bundles each and infect 15 trees daily or 400 during the season. The infection of a coupe of 300 acres will, therefore, employ 25 to 30 coolies for about one month. Collection of both *phunki* brood-lac and the lac from the previous coupe will take somewhat less time. Each tree will produce in a good season 3 to 5 seers of lac. Assuming 1 seer only as a moderate average the total yield will be 300 maunds.

Details of cost:—

	Rs.	a.	p.
Quarter services of one Overseer on Rs. 25 per mensem for 6 months	37	8	0
Two guards on Rs 12 each for 6 months	144	0	0
Pruning 12,000 trees, say	750	0	0
Infecting 12,000 trees, say	300	0	0
Collection, dry cleaning, etc., of 300 maunds at Rs. 4	1,200	0	0
300 bags	225	0	0
Depôt charges	100	0	0
Carting at annas 8 per maund	150	0	0
Sundries	93	8	0
Total	3,000	0	0

or Rs. 10 per maund.

During 1912 the Calcutta price of *biuli* lac varied from Rs. 11-12-0 to Rs. 15 per maund and during 1913 from Rs. 15 to Rs. 26. Prices secured during 1918 to 1920 have, of course, been much higher. It is clear, therefore, that the profits on the departmental

cultivation of lac should be high, but it is also clear that the labour required for intensive cultivation on a large scale will be considerable. In the example taken above, no debit has been shown for capital charges such as buildings, which will not be heavy, or for rent, which it is impossible to estimate.

General.

The enemies of lac have already been dealt with in Chapter I. It is impossible to suggest any safeguards against predators and parasites until more is known of their life-histories and habits. In the meantime the use of clean brood-lac as free as possible from parasites and predators is to be encouraged. Imms and Chatterjee found that lac from the Hoshangabad district of the C. P. was cleaner than any other. Enquiries for brood should be made at Itarsi and Bankheri. The Divisional Forest Officer might be able to supply some, but most of the lac in this district is grown outside Government Forests

Labour conditions are an important consideration and have already been described The selected site must be one in which the local labour supply is plentiful and not predisposed against the cultivation of lac The remedy is to offer good wages and to show that up-to-date methods of cultivation, and particularly the collection of *phunki* lac only for the market, tend to foster and not to destroy the insect. When it is demonstrated that scientific methods ensure better results and bigger profits, the cultivator will not be slow in adopting them. Meanwhile the method described above, of reserving a few trees for brood purposes, is extending and will be found an excellent stepping-stone towards the adoption of more scientific methods when they are known

The application of improved methods of cultivation

All the authorities who have written on the subject have suggested improved methods of lac cultivation, but it is not so easy to give practical effect to such methods or to ensure their general do ption. The Forest Department is probably the best adapted for the work, particularly in the Central Provinces where the Forest staff is in close touch with the cultivator throughout the greater part of the Province. There are certain areas, however, especially in the Chattisgarh Division, where there is little or no Government Forest and where in consequence special arrangements will have to be made. The other important lac-producing province, Bihar and Orissa, has

very little Government Forest and only a small Forest staff. Where there is Forest staff, as in Palamau, the Santhal Parganas, Singhbhum and Sambalpur, the work can be carried out departmentally, but in the very important lac districts of Manbhum, Ranchi, Hazaribagh and Gaya, there is practically no Forest staff. In these districts, as in the Chattisgarh Division of the Central Provinces, special arrangements will be necessary. The Central India States and the Feudatory States of Orissa and the Central Provinces will doubtless, in their own interest, adopt similar measures within their respective territories.

The work that is required may be divided into two heads, the distribution of brood and the demonstration of improved methods. Though different in purpose, these two objects may be effected by a single means. Several writers have already suggested the establishment of what may be termed Lac Brood Farms, namely areas containing lac-growing trees managed by Government for brood and demonstration purposes. If they are to be effective, they must be fairly large, say 100 to 200 acres according to the number of trees contained. These farms would be established throughout the lac-growing area.

A start would be made with suitable sites in existing Government Forest, and the operations subsequently extended by acquisition, as required. Each such farm will require an Overseer and a staff of several guards to supervise the work, guard against theft and issue the brood. It is confidently expected that the farms will not only be self-supporting, but will even bring in revenue, unless a very decided slump occurs in the shellac market. The best localities for such farms are naturally near the local centres of the stick-lac trade, so that they will be within easy reach of the cultivators and are likely to become known and get talked about. Suggestions for suitable sites will be found in the Local Notes attached to this report. It is understood that the Government of Bihar and Orissa are now contemplating a scheme on these lines in Khas Mahal near Daltonganj in the Palamau district of Chota Nagpur. When this farm is in full working order, it may serve as a model.

It is suggested that the whole of the lac be reserved for brood and sold to cultivators or advanced in time of need, when there is assurance that it will be used for the purpose intended, but it is very

important that the price should be carefully settled. If the price of brood-lac is fixed too low, there is a danger, in fact a certainty, that it will be bought up and sold by speculators to the stick-lac dealers. The price must therefore be somewhat above the current stick-lac price, and it is suggested that it be based either on current clean *bindi* lac prices or on Calcutta TN rates. In the former case, as brood-lac contains the stick, the desired safeguard will be secured if it is sold at the local *bindi* rate. If the Calcutta TN rate is adopted as the standard, then different rates will have to be calculated for different kinds of brood :—

Palas brood should be one-half Calcutta TN rates.

Ber and Ghont should be slightly more than half, say three-fifths.

Kusum brood should be seven-tenths of Calcutta TN rates.

These rates will be absolutely fair and a mere fraction of what brood-lac is often sold for nowadays, yet they are sufficiently high to prevent unscrupulous dealers buying up the brood as a speculation in stick-lac, and will ensure that only the man who wants it for propagation will buy it. Any reduction of the price below these figures, as an inducement to purchase, can only defeat its own purpose.

In the management of the brood farms, the following facts must be remembered. For two months in the year, that is one month before the emergence of the larvæ of each brood, the staff will be very busy both collecting and disposing of brood and also infecting and guarding trees within the farm, so that the staff must be large enough to carry on both these operations simultaneously. The brood can be collected for sale about one month before emergence is expected, but during the first fortnight no more should be collected than can be disposed of in a few days. During the second fortnight the whole of the brood may be collected and should be stored in a cool, airy store-room, laid out in rows on bamboo supports. After the brood has emerged any lac remaining will be scraped from the stick and sold in the markets in the ordinary way.

Lac specialists.

The Overseer in immediate charge of each brood farm should also be qualified to undertake demonstration work, and should be encouraged to inspect the lac operations of neighbouring cultivators and zamindars

and to explain the Government methods. In addition, in each of the two important lac provinces, Bihar and Orissa and the Central Provinces, at least one officer—a lac specialist—should be appointed to supervise the work of the farms and to conduct the necessary research operations. The qualifications required in this specialist would be, first and foremost, those of an entomologist, so that he may be in a position to study the insect and its enemies. Some knowledge of Botany is equally necessary and is generally found in an entomologist.

CHAPTER VI.

COLLECTION AND STORAGE.

Collection.

The collection of lac often begins as early as the latter half of March for Baisakhi and early September for Katki. Needless to say, at these periods the lac is not fully developed and the cultivator collecting so early is deliberately sacrificing an increased yield for the sake of immediate profits, and also in many cases is hoping to minimize the risk of theft. Collection will continue until all the crop, except such as may be reserved for brood, has been harvested. The lac is then separated from the twig either by scraping, by soaking in water and then splitting the twig when the lac falls away (Ber only), or, if the lac is *phunki*, by pounding. It must now be carefully dried in the shade and for this purpose is spread out in layers not more than four or five inches deep and repeatedly turned over until dry. *Ari* lac, since it has been collected before the insects swarm, is full of moisture and therefore requires much more careful and prolonged drying than *phunki* lac. Once dried the lac, now known as *dal* lac, is sometimes winnowed to remove all sticks, stones, bits of wood and fibre, sand, and other foreign matter, and is then known as clean stick-lac or *biuli* lac.

Where lac is grown by villagers in the gardens around their houses, the above processes are easily arranged for. When, however, lac is grown on a large scale, considerable attention has to be paid to method and suitable arrangements made so that the stick-lac, cut each day, can be removed from the wood and can start drying from the day of collection. This applies more particularly to *ari* than to *phunki* lac, but, in any case, the quicker the lac is dried and finished, the better.

The above processes are, of course, applied only by the more advanced cultivators One has only to visit any stick-lac market to realize how careless the preparation of lac may be. Frequently the lac is collected *ari*, when it is thoroughly wet, saturated with moisture, and contains the living bodies of the mother insects distended to large size and occupying fully 25 per cent. of the bulk of the lac. It

will be kept anyhow, in the first place that comes handy, and never touched until a possible purchaser arrives, or until a convenient bazaar day occurs. Heat generates, fermentation sets in, and the result is an evil-smelling mass of lac, wood and fœtid animal remains, which eventually sets into a solid lump known as "blocky" lac. Blocky lac is the bugbear of the manufacturer. Not only is it difficult to crush and to separate the wood and fibre, but the fermentation of the organic matter makes the dye extremely difficult to wash out, the lac itself difficult to melt and the addition of rosin (colophony) a necessity to reduce the melting point. The better class manufacturers will not touch such lac and it is usually purchased at a discount by the makers of TN and lower class shellacs.

The collection of lac cultivated on a large scale presents no easy problem, especially if the method recommended in Chapter V is followed. Such cultivation is nearly always in forests, where labour is more or less difficult to get. It is a fact that most of the lac-growing areas are in *kharif* country, where the field crops ripen in the autumn, comparatively little being grown in *rabi* areas, where spring crops are cultivated. The larger growers of lac, particularly the Damoh Government Forests and the Esociet, have tried to arrange their work so as not to compete for labour with field cultivation. This is the reason why they use the Baisakhi crop primarily for brood and the Katki for the market, despite the fact that there is some reason to believe that Baisakhi lac is of better quality than Katki. If therefore, as has been already suggested, both crops are to be commercial crops, some special arrangements will have to be made.

The following method is suggested for areas where labour is, as it usually is, particularly difficult to get at the beginning of the rains. The proposal is to use both crops as commercial crops, but to use the Katki and not the Baisakhi as the principal brood crop. As soon as the Baisakhi crop matures, that is to say reaches its maximum bulk, as much of it as possible will be collected for the market, leaving as a minimum sufficient only to inoculate the trees in the coupes reserved for the summer brood. The lac used to inoculate these trees will eventually be collected *phunki*. When, in due course, the Katki crop matures, only such lac as is required for brood purposes will be collected before the emergence of the larvæ; the balance will be left on the trees and will be collected *phunki* after

swarming has taken place. During this period, the extension of work by opening up and inoculating new cropping series will be carried out.

The advantages of the system are obvious. The bulk of the work will be carried out in the cold weather; and more, again, will be done in the hot weather than in the rains. Work in the unhealthy seasons of the year and competition with agriculture for labour are thus reduced to a minimum. It is true that the system does to some extent depart from the general principle already enunciated, that only *phunki* lac should be removed from the forest, for the Baisakhi crop will have to be collected *ari*. This is, however, unavoidable, if lac cultivation is not to compete for labour with field cultivation. Moreover the manufacturer emphasizes particularly the fact that Katki lac contains a larger percentage of colouring matter than Baisakhi, and therefore attaches special importance to the collection and sale of the former in the *phunki* condition

The above is merely a brief outline of suggestions in one particular case. Modifications will be necessary to meet special conditions, *e.g.*, where *rabi* crops are the staple form of cultivation, or where Kusum is the host-tree There is one point which can never be over-emphasized. When the lac in one coupe is finally collected, it is essential that all the lac should be removed, whether for the market or for the infection of the next coupe in the series or for both; otherwise the whole object of the proposal, the resting of the host-trees after a heavy crop, is defeated.

Storage.

Phunki lac is comparatively easy to deal with. It contains very little organic matter and much of the natural moisture of the lac has dried out of it during the extended period for which the lac has remained on the tree. *Ari* lac is wet and living and must, therefore, be dried much more carefully according to the methods described above. When stick-lac has to be stored, as it frequently must be, it still requires some attention, however carefully it may have been dried. Even *phunki* lac contains some dead larvæ which died naturally, and also the shell of the mother There is always therefore a liability for the lac to ferment and block. The best method of storage is to keep it in layers of about four to five inches deep in a dry, airy and cool place, where it should be daily raked over. The best apparatus seen

consisted of perforated racks, a good imitation of which can easily be made with strips of bamboo or with bamboo matting.

Many authorities have drawn attention to the fact that considerable loss takes place during the storage of stick-lac owing to the action of predaceous insects. The manufacturers are, however, unanimous that no appreciable loss occurs in their godowns. Both views are possibly correct. If recently cut lac is inspected it will be found to be infested with the larvæ and pupæ of *Eublemma amabalis* and other predators, which must destroy an appreciable quantity of lac. It usually, however, takes weeks and often months for lac to complete its transit from the tree to the manufacturer's godown, and during this period the predators either die or emerge and no appreciable loss will occur actually in the godown. The question whether loss does occur can only be decided after a careful test. In the Agricultural Journal of India, Vol. III, pp. 176—7 and in his " Indian Insect Pests " (reproduced by Misra as an appendix) Maxwell Lefroy has described a method of fumigating stick-lac with carbon bisulphide to exterminate these predators. A sample of about one maund of stick-lac freshly plucked and well infested with predators should be divided into two exactly equal parts by weight. One part should be treated as described by Maxwell Lefroy and, after having been cleaned of predators, should be stored so as to prevent reinfection. The other part should be stored in the usual way. At the end of about two months, the co-operation of a careful manufacturer is required, who will convert both samples into grain-lac ; and a comparison of the resultant weights will show definitely whether any loss occurs from the action of predators after the lac has been collected. Should appreciable loss occur, the question of preventing it arises. Maxwell Lefroy states that one-and-a-half pounds of carbon bisulphide are required per ton of stick-lac. Carbon bisulphide is an expensive chemical and an arithmetical calculation will show whether the value of the lac saved is more than the cost of saving it or not. If not, experiment is necessary to discover a process involving the use of cheaper chemicals.

Troup (Indian Forester, Vol. XXXVII, p. 245, Measures for the destruction of moths predaceous on lac) brings to notice the fact that the emergence of the parasites and predators on lac usually occurs after the swarming of the lac insects. He suggests, as a

method of exterminating them, that all lac should be collected immediately before the swarming, except such as is required for brood purposes, which should be removed as soon as the larvæ have emerged. All lac should be at once removed and treated under moth-tight screens or fumigated as proposed by Maxwell Lefroy (Agricultural Journal of India, Vol. III, p. 176). The method seems well worthy of trial and will fit in with the methods of collection of the Baisakhi crop suggested in Chapter VI.

CHAPTER VII.

LAC RENTS AND LEASES.

By far the greater part of the lac-producing area of India is in the hands of the Feudatory Chiefs and large land-owners. It was not so long ago, however, that the landed proprietor began to realize that an appreciable income could be recovered from his tenants on account of lac cultivation. Since then the importance of the industry has increased and in some parts his income from lac is very much greater than that from land rents. In these circumstances, one would expect that all proprietors would take steps to foster and increase the cultivation of lac in their estates; unfortunately there is only too large a proportion of the less enlightened who are only interested in obtaining a maximum of rent from lac cultivators from year to year with little or no provision for extensions.

The systems adopted in leasing the right to cultivate lac naturally vary considerably in different areas. The agreements are either verbal, or consist of a few written terms now more or less stereotyped by custom. Only in Government Forests and in adjoining zamindaris is any complicated form of lease employed. The period of the ordinary agreement between a proprietor and his lac tenant may be one year only, or may extend in Chota Nagpur to three or five years and in the Central Provinces to six or ten years or even longer.

In Hazaribagh and Gaya districts there are two systems, one of cash rents for the right to cultivate, by which the lac becomes the property of the lessee; the other of produce rents, by which the landlord provides the brood and takes seven-eighths of the crop. Independent cultivators will not accept this form of lease, and the commonest practice is for the landlord to take three-fourths of the crop; the brood being supplied by the landlord or lessee according to their relative business acumen. As the cultivator is frequently an aboriginal, and considerably inferior in intelligence to the landlord and his agents, he generally gets the worst of the bargain in one way or another. In many cases, however, tenants have succeeded in establishing a customary right to cultivate lac for which they pay

a fixed rent in cash or produce, and cannot be ejected at the will of the landlord. Cash rents are now becoming more and more popular, and are preferred by the landlords on account of the ease of collection; they are also preferred by the capitalists and banias, who are now taking an increasing personal interest in cultivation and frequently lease large areas from the zamindars with a view to securing their own supplies of lac.

In Palamau district developments have been slower. The following is quoted from para. 418 of the final report of the Palamau settlement.—

"It is only within the last thirty years or so that the landlords of Palamau have begun to regard lac seriously as a source of income but since then, spurred on no doubt by the booms of 1895 and 1905, they have done so to such good purpose that the raiyats' former privileges are in most villages annihilated In a few villages, it is true, the raiyats still hold their lac-bearing trees rent free, in a very few the trees are included with the holdings in a common assessment, and in a few more the trees are held upon a fixed rent. But, in the great majority of cases, lac trees are entirely at the disposal of the landlords, and (I quote from Mr. Hignell, a former Deputy Commissioner) 'the rates charged are only limited by the landlords' discretion, and the tenants' inability to pay more than the lac on the tree will fetch in the market.' The trees are let out just before the sowing time. No count is actually made, but the tenant engages for a definite number of trees. The number has nothing to do with the actual facts and is a mere matte of haggling. The landlord's agent endeavours to make the raiyat agree for as large a number as possible, while the raiyat attempts to represent that there are not so many trees available. The rent is fixed later on by the landlord when the crop is ready for cutting; he considers current prices and the general nature of the crop from his own point of view, and acts in such a manner as to justify Mr. Hignell's criticism."

In Palamau, Government have decided that tenants in Government estates shall enjoy the annual produce of all trees which grow on their holdings, free of charge. Lac-bearing trees outside such holdings may be given on lease in suitable blocks for a term of five years, preferably to one or other of the settled tenants of the village; and in such cases the rates are calculated at one anna per tree, or at

half an anna, according to the locality, or even at lower rates at the discretion of the Deputy Commissioner.

In the Kolhan (Singhbhum) Government Estate, the tenants cultivate lac free on Ber trees planted near their holdings and for other trees rent is charged at one anna per tree for Palas, and four annas for Kusum.

In Manbhum the raiyats have full right to cultivate lac on Ber trees in their homestead lands, and pay no separate rent for this right. This is the main type of lac cultivation in this district. For other trees, Palas and Kusum, there is no fixed custom. In one village the raiyats will cultivate without paying rent, in another a rough rental will be charged, and in a third the landlord will do the cultivation himself. The Settlement Department records the rights as they are found.

In the Sonthal Parganas the zamindar is entitled to realize rent (one-half to four annas) for each tree on which lac is grown by raiyats, whether the tree is in the raiyat's holding or not; but local custom is usually the guide. In Damin-i-koh Government Estate, Government is entitled to collect a separate rent for lac, but does not do so. The export of forest produce is, however, controlled by the Forest Department who collect a royalty under the rules of Rs. 1-4-0 per maund, and sell to contractors on a three years' lease the right to collect this royalty in bazaars.

In the Central Provinces, where Government Forests are common, it is only natural to find that the methods of landholders are influenced by the actions of the Forest Department, whose lease forms are often copied almost verbatim. The lac on trees growing on malguzari waste land is the absolute property of the malguzar. That on trees growing in a tenant's holding has now been definitely settled, by section 96 of the Central Provinces Tenancy Act of 1920, which comes into force on 1st July 1921, to be the property of the tenant concerned. The methods employed by the malguzars and zamindars vary considerably. Some will give a lease for a whole estate to a capitalist, who may simply act as a monopolist and sublet the right of cultivation to tenants. In Bhandara the malguzars give out numbers of petty leases for long periods, the agreements being in simple written form, or even merely verbal. Owing to the enormous increases in the value of lac leases in 1919-20,

some unscrupulous landlords took advantage of the ignorance of their lessees to eject them from areas leased, which they were easily able to do since the leases had been irregularly executed. The lessees are now more circumspect and are registering their leases. A curious form of lease was discovered in the Chattisgarh Division. The lessee is a monopolist, and agrees to a minimum purchase rate with the cultivator. The latter, however, is not compelled to sell to the monopolist, and if he wishes to dispose of his lac elsewhere must pay this minimum rate to the lessee. The result is, that the cultivator is encouraged to sell to the monopolist, for, if he sells to anyone else, he has to pay a fine; while the lessee must offer reasonable rates or the cultivator will take his lac elsewhere. Some land-owners, notably the zamindar of Khujji (Drug district), are taking up lac cultivation on their own account and have been realizing very handsome profits. It is hoped that this method will extend, as it will lead to more stable production At present it is chiefly confined to Mahomedan landlords, as high caste Hindus are deterred by religious scruple from following suit.

Sufficient has been said to show that the smaller landed proprietors, who constitute the majority, take but little interest in lac cultivation, save to secure from their tenants as large a share as possible of the profits of cultivation. So much has this been the case, that, during settlement operations, instances have occurred where tenants have cut down the trees in order that they may not be recorded. This has caused alarm among manufacturers, but no permanent harm results, as the trees coppice, and in a few years are ready to grow lac again. The demands of zamindars undoubtedly have a serious effect on the production of stick-lac, particularly when the market is low or falling. As education spreads, it will undoubtedly be realized that a careful and definite settlement of lac rents is conducive, in the long run, to careful and profitable cultivation. The lenient and far-sighted policy adopted throughout the Government Estates of Bihar and Orissa will, it is hoped, be adopted in their turn by neighbouring zamindars.

As regards Government Forests, serious attention has hitherto been paid to lac only in those of the Central Provinces. There, the usual practice was to lease lac areas to contractors Sometimes the leases ran for as long as three years, but recently they have been

given for one year only. The following are important clauses in the C. P. type of lac lease. They have occasionally been adopted by other provinces also:—

V. That the lessee agrees —

* * * * * * * * *

(*b*) that as far as possible all lac shall be collected after the insects have emerged from it;

(*c*) to leave unbroken, at each harvest of lac, at least two-thirds of the total quantity of seed-lac on each tree to ensure the propagation of lac during and after the period of this agreement.

Clause V*b*. is a dead letter and is hardly necessary in a long lease. In Clause V*c*., two-thirds is too high a proportion to ask for, and it is very doubtful if the provisions of this clause are ever carried out in practice.

In 1915—17 a special form of lease was introduced in Damoh, by which the contractor paid entirely on outturn, and a sliding scale of royalty was arrived at by deducting the expenses of cultivation, freight, manufacturing charges, brokerage, and profits, etc., from the average rate of TN shellac at Calcutta, as published by a well-known firm of brokers. The result was divided by two, and was the rate per maund, paid as royalty by the contractor. The expenses were fixed at Rs. 28, so that the formula was, where TN is the rate per maund of TN shellac at Calcutta:—

$$\text{Royalty } \frac{TN-28}{2}.$$

The basis of the system is excellent, theoretically. The price of shellac varies widely and the value of stick-lac follows in proportion, so that if a long term lease is executed for a fixed cash payment, the lessee runs a risk of loss if the price of shellac falls, whereas if the price rises the lessor gets considerably less for his lac than it is worth. By adopting the Damoh method, both sides are protected. If the price of shellac rises, the royalty paid by the lessee automatically rises, and if the shellac rates fall the royalty paid automatically falls. Thus the lessee is insured against a fall in the market and the lessor is secure of contingent profits following a rise.

Payment by outturn, however, has never been found by the Forest Department to be quite satisfactory. The staff required for

checking purposes is large, and the necessity for each party closely to watch the other invariably breeds ill-feeling among the respective subordinates; relations become strained and the efficiency of the work is bound to suffer. Moreover, it is almost impossible to word the agreement to cover all eventualities. The Damoh lease, sound though it was in principle, was not a success, and on expiry of the period was not renewed. Subsequently the work was done departmentally and has been so successful that it has been decided to extend departmental work to other forests as rapidly as possible, and an officer is to be appointed to carry out research work, to suggest working plans, and generally to advise local officers.

Contracts will, however, continue to be necessary, and the following are suggested as suitable guiding principles for adoption in framing them :—

(1) In order to ensure that a contractor will interest himself in extending cultivation a long lease is necessary Ten years is suggested, and six years is the absolute minimum, which will give a contractor a chance of materially extending cultivation and of reaping a fair profit from the result of his industry. Short period leases defeat their own object, for all that the contractor will do will be to get as much lac as possible from the forest during his incumbency and to leave nothing; the next crop is bound to fail and new brood must be introduced, always an expensive matter.

(2) The last crop in the period of the lease must be left by the contractor until it is *phunki*, so as to provide brood for the next crop, or at least the proprietor (Government) must reserve the right to utilize the last brood for purposes of infection, before surrendering the *phunki* lac to the contractor. For the other crops no restrictions should be placed on the contractor. He may collect the crop as he likes, but should be encouraged to adopt the principles advocated in this report. In addition, the usual clauses, which prevent the felling of trees, etc., must of course be retained.

(3) It is customary for the Forest Department leases to begin on the 1st of July, and to terminate on the 30th June

This means that the lease begins and ends just as the summer brood is swarming, a most unsuitable time for a lac lease. The best arrangement is one by which the lease commences on the 1st of April, and ends on the 31st March. The contractor thus gets several months in which to collect his last (winter) crop, *phunki*, and the new contractor gets several months to make his arrangements before the swarming of the summer brood.

(4) To eliminate the speculative element, a sliding scale of payment should be adopted, based on the Calcutta TN rates. By this means the undesirable contractor who takes up a lac lease solely as a gamble, makes huge profits if it booms, and fails completely if prices fall, is ruled out. The desirable contractor will get a just reward for his industry in extending cultivation; he will get no undue advantage from merely spasmodic increases in prices, but will be protected from loss when prices fall. As a *modus operandi* it is suggessed that the sole right to cultivate lac for say ten years, in a selected forest, be put up to open auction. Prior to accepting any bids, the auctioneer will state the Calcutta TN rate of the day, and explain that the bid accepted will be the amount payable during the first year only. To calculate the amount payable in any subsequent year the original bid will be increased or decreased by the same percentage as that by which the average TN rate during the previous year has increased above or decreased below the original Calcutta TN rate at the date of the sale. As an example, let us assume that the forest is leased for ten years on a day when the Calcutta TN rate is Rs. 200 per maund. The highest bid of Rs. 10,000 is accepted and is payable as the price for the first year of the contract. During the first year the Calcutta TN rate fluctuates between Rs. 210 and Rs. 160, the average being Rs. 190. It has, therefore, fallen from Rs. 200 to Rs. 190, a decrease of 5 per cent. During the second year the cultivator will

pay Rs. 10,000 less 5 per cent. Rs. 9,500. During the second year foreign demands increase and the average TN rate goes up to Rs. 250, a rise of 25 per cent. The price payable in the third year is, therefore, Rs. 12,500. During the third year there is a slump to Rs. 100, a decrease of 50 per cent. which ordinarily would be sufficient to ruin the contractor. He is saved, however, by the fact that the price payable during the ensuing year goes down to Rs. 5,000, and he can still cultivate lac at a profit. The chief claim of this system is that, except in the first year, the rate payable at the beginning of each year depends entirely on the profits made by the contractor during the previous year. He is protected against losses due to trade slumps and the owner of the forest gets his share of the profits when trade booms. It is claimed also that the system will tend to stimulate the regular cultivation of lac as the profits will be more uniform.

There may of course be some difficulty in getting the less advanced contractors to realize the merit of the agreement. But once realized, the system is likely to appeal to both parties The difficulty of ascertaining the correct average price may be overcome by reference to published statistics such as those of Messrs. Moran and Co.

CHAPTER VIII.

MANUFACTURE.—PART I.

It is unnecessary to discuss here in detail the chemistry of lac. This subject has been dealt with very fully by Tschirch (Die Harze und die Harzbehälter, pp. 812—830). See also Puran Singh's note on the Chemistry and Trade Forms of Shellac, Forest Bulletin No 7. It will suffice to mention that shellac appears to be composed of a complex mixture of resin acids, resin esters and a wax. The resin acids are probably derived from hydroxy fatty acids.

The chemistry of shellac

As is well known, shellac in storage gradually becomes less soluble in alcohol and it has been suggested by Puran Singh (loc. cit) who obtained the same results by heating shellac, that this change is due to the formation of either anhydrides or lactones. Puran Singh further states that the solubility of shellac can be restored by soaking in water for some days. The solubility of shellac is of the greatest importance to the manufacturer, and to the consumer who uses shellac in solution. Trade experience seems to indicate that the rate of decrease of solubility is proportionate to the area exposed to the air. Thus grain-lac becomes insoluble more rapidly than shellac, and shellac more rapidly than button-lac. One manufacturer has stated that TN shellac loses 5 per cent. solubility per annum during the first three years, 10 per cent. during the next three years and 15 per cent. in subsequent years.

The quality of shellac appears to depend very largely on the relative proportions of the resin and wax it contains. It has been definitely proved that the proportion of wax to resin in stick-lac is greater than in the shellac manufactured by the manual method (see Hatchett's analyses quoted by Puran Singh—loc. cit.) and that the surplus wax is left in the *kiri* or residue. The alcohol processes presumably retain the whole of the wax in the shellac while other machine processes are believed to retain less wax in the shellac than does the manual method. This may be the explanation of the differences between hand-made and machine-made shellac and would indicate the lines on which research in this subject might take. The

manual process has hit off by sheer accident the proportions of resin and wax which produce the best quality shellac known. So little research has, however, been carried out in this branch of the subject that no definite facts can be stated and the true explanation of the difference between hand-made and machine-made shellac may be found to be entirely different from that suggested above.

The properties which appear to make shellac the valuable article it is, are its insolubility in water and ready solubility in other cheap solvents; its comparative hardness among gums; its immunity to change when exposed to the atmosphere; its elasticity and power of adhesion to smooth wood and metal surfaces on which it can be spread in very thin layers, its flux or power to assume with great exactness the shape of a mould to which it is applied; its power of electrical resistance

At present the requirements of the trade in a good shellac are, firstly, cleanness, freedom from dirt, insoluble matter and adulterants; and, secondly, paleness of colour. Low grade shellacs are dark orange and high grade shellacs run up to a very pale yellow. This prejudice in favour of pale colour can be of no real importance to many consumers, especially to the gramophone record manufacturers who take nearly half of the shellac manufactured. Unfortunately prejudice has so firmly fixed colour as the standard of the trade that even when a more practical standard is discovered it will be difficult to get it recognized.

Analysis

No complete analysis of shellac has ever been published, and the usual procedure of the chemist to whom samples are submitted for analysis is to apply certain tests from which definite facts can be deduced. The two most important tests are:—

1. The determination of the percentage of insolubles in boiling alcohol.

2. The determination of the percentage of rosin. Details of the methods employed will be found in Allen's Commercial Organic Analysis, Volume IV (London, J. and A. Churchill).

Methods of manufacture
The manual process

In the old days in India there used to be considerable local prejudice against the manufacture of shellac There is still current a proverb "Sau kasahi ek lahi"—'One lac manufacturer is as bad as a hundred

PLATE I

Coolie women grinding and sifting lac

butchers "—referring to the destruction of insect life caused by the collection and manufacture of lac. It should not be forgotten that, in its earlier history, the industry concentrated on the manufacture of lac-dye, which was composed chiefly of the bodies of the insects. In those days, therefore, it was necessary to collect before the fresh brood had swarmed. This practice still survives although it is unsatisfactory inasmuch as lac is now valued for its resinous properties and not for the dye, which must be entirely washed out if the quality of the shellac is to be good. Hence the proverb and the prejudice survive although they have lost much of their force.

The object of manufacture is principally to remove the crude lac and remove the dye, fibre, animal remains, and impurities. Care has, however, to be taken that none of the valuable properties of shellac are prejudicially affected by manufacture. The following is the process adopted in the larger factories and in the modifications, in the smaller factories and in the cottage industry.

The first step is to clean and roughly grade the lac. This process is locally known as *halorna*. The stick lac is broken and the broken fragments separated from that still adhering to the parent twig. The former is called *gulla* and, being the purest raw product, is used for first quality shellac. The latter is called *phal* and is used for second and third quality.

The *phal* is now sifted *(chalna)* through a sieve. That which passes through is called *ekiaya*, the lowest quality of all, or grain-lac or *kachha chaori*. The *phal* which remains on the sieve and also the *gulla* are then ground in stone mills, *chatki* or corn crushing machines, which break off the lac from the stick. The large sized Kusum lac and certain better quality Baisakhi lacs have to have specially adapted rollers to break them up as they will not pass through the ordinary corn-crusher. Sieves and corn-crushers may be worked by hand or steam power.

The lac is now winnowed carefully in basket work trays *(sup)* by women who by this process are able to get lac wonderfully clean of sticks and dirt and are also adepts at recovering the last traces of lac from the refuse.

The lac, now known as unwashed grain-lac *(kachha chaori)*, is next taken to the washing department. This consists of a cement floor on which stand rows of stone pots, known as *nand* or *athali*,

These vessels are about 2′ 6″ high and 2′ 6″ in diameter at the top and centre, tapering to the base which is about 1′ 6″ in diameter. The inner surface is rounded and serrated regularly to a depth of about [illegible]nth of an inch. Above each *nand* is a horizontal bamboo at a height about 4 ft. from the ground. The unwashed grain-lac is put into the *nand*, covered with water and allowed to stand overnight. In the morning the washer or Ghasandar (literally "one who rubs") subjects the lac to about three washing operations known as *mijao*. He stands in the *nand*, grasps and leans on a horizontal bamboo and rubs the lac with his feet against the serrated sides. This crushes the [illegible] and washes out all the dye

[illegible] *mijao* the water is allowed to settle. A scum [illegible] fibre and cell matter and a small quantity of lac, [illegible] is removed, dried, winnowed and picked to [illegible] as possible, and then sold to cottage labourers [illegible] hand for further grains.

[illegible] ng and removal of the scum, the water, which [illegible] n suspension and solution, is run off and gene- [illegible] : without value. In some factories, however, [illegible] in vats and the dye allowed to settle for some [illegible] tation with lime. It is then recovered, pressed [illegible] at a bare profit as commercial dye or *rang batti*. [illegible] local field labourers are allowed to remove the dye [illegible] as manure.

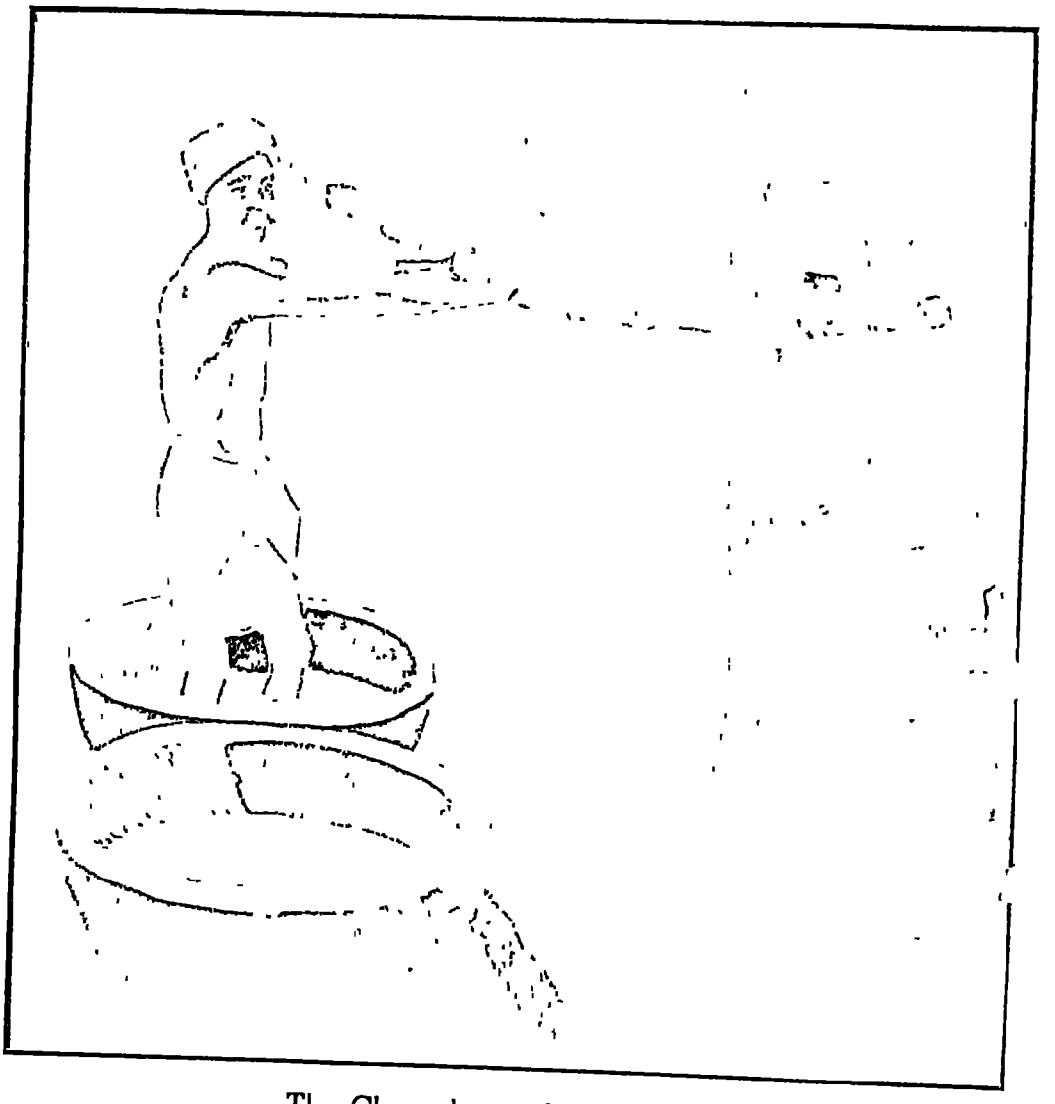
After the third and final washing the grain-lac is taken out of the *nand*, strained through a cloth and washed in a basket with clean water to remove the last traces of dye, it is then spread on a cement floor to dry. It is now known as clean grain-lac or *safa chaori*. The term seed-lac is frequently used synonymously with grain-lac, but as the former term is also used to connote brood-lac, it is advisable to speak only of "grain-lac" and "brood-lac" and so to avoid all risk of ambiguity.

The grain-lac is now winnowed in a *kula* and the following classes separated :—

1. *Chaori*	...	... large grains.
2. *Karola* or *Kusmi*	...	.. small grains.
3. *Molamma*	...	... fine grains.

Chaori or *Karola* if made from Kusmi or good Baisakhi have now a fine golden-yellow colour. Poor Baisakhi and Rangeen lac

PLATE. II



The Ghasandar washing grain-lac.

give a darker colour, brown or even dark purple. *Molamma* is a fine dark purple powder.

The grain-lac is now taken to the blending room and mixed in the proportions necessary to produce the different grades of shellac. The *molamma* can only be used in making TN grade shellac and high class manufacturers discard it altogether and sell it to bangle makers. It cannot be used for high grade shellacs as it contains dirt too fine to be easily separated from the lac in the process of manufacture. Very great care is necessary in blending the different kinds of grain-lac, which are of by no means constant quality. Kusum grain-lac is always better than Baisakhi and Baisakhi than Katki; but at the same time Kusum, Baisakhi and Katki all vary with the locality from which they were obtained and with the year and time of the year in which they were collected. Obviously, therefore, if manufacturers are to keep their grades and marks of uniform quality, great skill is required in the blending room. At this stage also most manufacturers add a little yellow sulphide of arsenic or orpiment (*hartal*) as a finely ground paste, thoroughly mixing it with the lac which is then again dried This addition is made to meet the requirements of colour. Grain-lac made from inferior or old stick lac is known to be difficult to melt, and in this case rosin or colophony is also added to lower the melting point. The proportion of added rosin is generally 12 per cent. but it is only used in TN manufacture. The rosin used is Canadian pure rosin; Indian rosin has been tried but is not satisfactory. Rosinous shellac is always sold as such and in view of trade requirements it can hardly be looked on as an adulterant.

The blended lac is now taken to the firing room and poured dry into cloth bags (*thaili*) sausage-shaped and about 30 ft. long by 2 inches in diameter. These bags are generally of cotton and, for the higher grade shellacs, closely woven; or even two bags, one inside the other, are used to ensure closer filtration. The chief operator in the firing room is the roaster or Karigar, a skilled and highly paid workman. He is assisted by the shellac stretcher or Bhilwaya, also skilled, and the bag twister or Phirwaya, an unskilled worker. The fire-place or *bhatta* is of Dutch oven shape about 3 ft. long, 1½ ft. high and 1 ft. in depth and contains a charcoal fire. Immediately in front of the *bhatta* is a smooth flat stone or *dongi* at one end of

which is a sunken depression or *pathri* containing water. The Karigar's implements are:—

(1) A baster or *charna*, a flat piece of iron 8" × 1½" × ⅛" with a wooden handle.

(2) A spatula or *pirbanda* similar to the baster but with no handle.

(3) A gouge or *kirkhodni* to rip up the bag and thus remove the refuse or *kiri*.

(4) A small bladed shovel or *karchhula* for attending to the fire.

The Bhilwaya uses the following implements:—

(1) A glazed porcelain cylinder 10" in diameter and 2' 6" long, full of warm water. It is known as the *pipa*, and lies at a gentle slope from the ground.

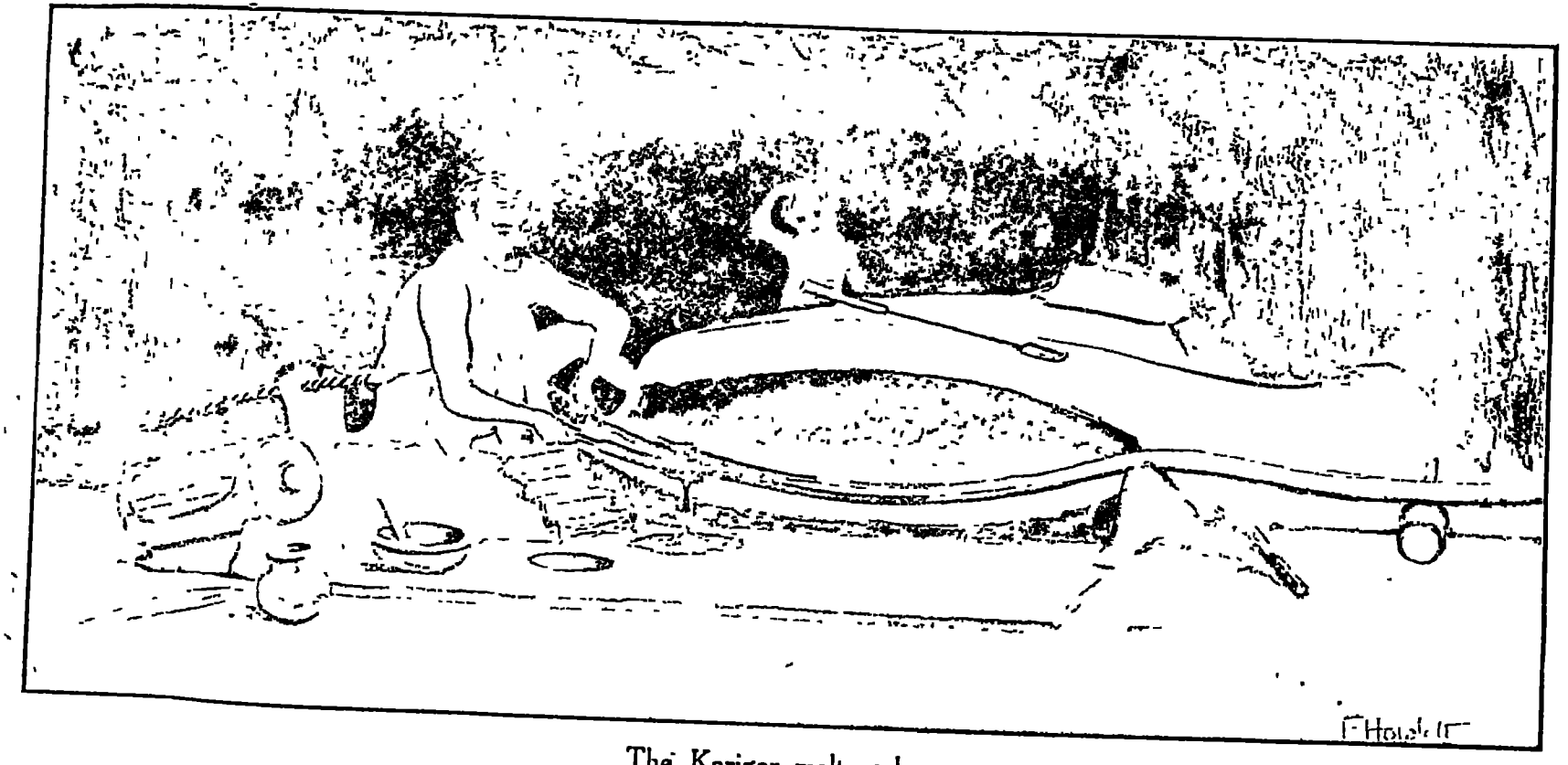
(2) A strip of palm leaf or *nera*.

(3) A piece of cloth.

The Phirwaya has a *charki* or *chorki*, a simple windlass, such as used in rope-making, and a row of wooden guide blocks with pegs called *dhanna*. The bag lies along the wooden blocks and one end is attached to the *charki*.

The Karigar sits at one end of the *bhatta*, just protected from the direct heat of the fire. The portion of the bag in front of the fire is called the *pera* and this is gradually twisted by the Phirwaya by means of the *charki*, so that it is thoroughly and evenly heated through on all sides. The Karigar then seizes his end of the bag tight in his hand. This action results in the *pera* being tightly twisted and in the lac being expressed through the cloth. The Karigar scrapes it off with the *charna* and throws it on to the *dongi*, kept damp with water from the *pathri*. Thence he repeatedly bastes it on the *pera* until it is thoroughly mixed and, by evaporation of the water, attains the correct consistency. He then takes it up on the spatula and pours the glutinous mass over the porcelain cylinder. The Bhilwaya spreads it out on the cylinder with his palm frond, polishes it with the cloth and then removes the sheet carefully from the cylinder. Seizing it with hands, feet and mouth, he stretches it from its original size of about 2' by 1½" to about 4' or 5' by 3' or 4', warming it in front of the fire every now and then to soften and anneal it. The process of manufacture is now finished. Each o.

PLATE III.



The Karigar melting lac.

the sheets so made (called a *panna*) when dry and hard is bro up into small pieces; irregular fragments (*e.g.*, where the sheet held) are picked out for remelting and the result is shellac (*cha* ready to be packed in cases for export. When a large quan refuse or *kiri* has accumulated in the *pera*, the Karigar stabs i the gouge and squeezes out the refuse or *kiri* which is pressed cakes. Even *kiri* contains a large quantity o shellac and is us sold for the manufacture of bangles.

When a bag is completely worked out it is twisted p to ½" diameter and sets into a hard stiff rod known as *d uri*. is boiled in a cauldron of water with Fuller's earth (*met* o The encrusted lac is thus recovered from the cloth in scum on the water from which it is scooped off and p cakes, called *passewa*, which can be remelted for TN m c The washed bags are mended by *darzis* (tailors) and again

The process for manufacturing garnet and button lac ilar to the above, but in the case of garnet lac the proces shed when the lac is removed from the cylinder; it is not stretched, but is allowed to set hard. In making button lac, the Karigar has a spatula with the end turned up in a "U" shape. He scoops up por ons of lac with this and pours them on a metal plate or palm stem where they spread out into a flat button about 2½" in diamet by ⅓" thick and set hard. Before they set the Bhilwaya stamps the firm's trade-mark on each button. The use of a palm stem is said to give a better polish to the buttons.

The above description applies to a good class factory employing primitive methods The smaller factories manufacturing only TN and Standard I, and also the workers in their own homes, do not necessarily go through the processes exactly as described, but in all essentials they are the same. In Jhalda and Balarampur (Manbhum district) the *nands* or washing vessels are usually sunk in the cement floor. The Ghasandar kneels down at the side of the *nand*, and the washing is done with the hands instead of the feet. In Jhalda many of the manufacturers use steam power to drive their crushing machines and some use mechanical washers consisting of horizontal cylindrical iron vessels within which revolves a bar carrying arms throughout its length. Water is supplied and the revolving arms break up the lac cells. It is claimed that by means of these machines

an grain-lac can be produced faster and more economically than by the ordinary method. In washing the grain-lac, if a high grade superfine shellac is to be manufactured, a little Fuller's earth is added to the washing water. This, however, dissolves some of the lac, causing a loss of about 5 per cent.

The Mechanical Process. Mechanical methods are chiefly confined to a few factories in Calcutta among which the principal are—

Messrs. Angelo Bros., Ltd., of Cossipore;

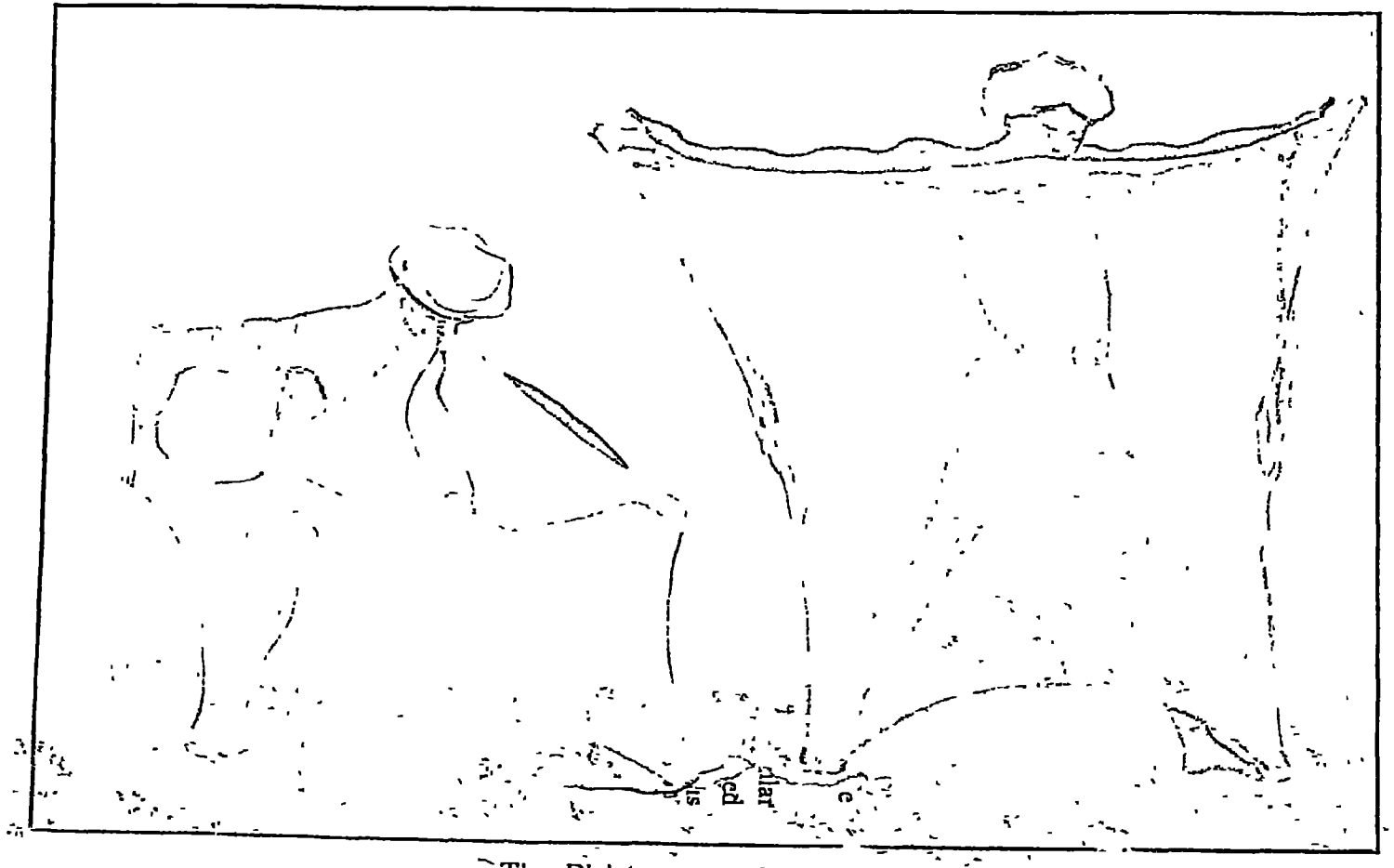
Galstaun, Esq.

There used also to be a mechanical factory in Rangoon, which has recently closed down in 1914, and the Esociet, Ltd, of Maihar, C. I., so manufacture shellac by machinery. Messrs. Angelo Bros. manufacture both garnet lac and orange shellac. The former is made by an alcohol process whilst orange is melted out by means of heat. Their best known mark is A. C. Garnet; and, of orange shellac, AB-TN, TN No. 1 and TN No. 2. The other manufacturers also have their own marks.

Alcohol solvents are generally used in the mechanical process, but little detailed information is available regarding the actual processes employed, which are in the nature of trade secrets. The apparatus consists of a mixer, an evaporator, and a condenser. Washed grain-lac is placed in the mixer, sufficient alcohol added and the whole agitated and heated until dissolved. The hot solution is now run off through a filter cloth into the evaporator where the alcohol, driven off by heat from a steam jacket, passes through a condenser back to the mixer. The clean molten shellac is drawn off through a tap in the bottom of the evaporator and made up into the form of garnet lac or shellac as required.

The chief advantages of the mechanical over the manual method are that shellac can be turned out more rapidly and in much larger quantities, is cleaner and more uniform. Practically all the available lac is extracted from the stick-lac. Indeed by the mechanical agency lac can even be extracted in remunerative quantities from *kiri* and other refuse, chiefly for conversion into the cheaper grades of garnet lac.

PLATE IV.



The Bhilwaya stretching shellac

On the other hand it is doubtful whether the mechanical process can produce a shellac so suitable for all purposes as the hand-made shellac. The precise difference between the two products has never been discovered, but a difference undoubtedly exists, and the successful manufacturer by mechanical methods will be he who is able to ascertain and neutralize this difference. Certain it is that, in removing the last traces of alcohol from the shellac, it is very difficult to avoid dehydration and consequent insolubility, and also some darkening of colour. The machinery employed is expensive and hence, if the stick-lac supply is short and the machines cannot work regularly, the capital charges are high.

There is undoubtedly a big future before the mechanical process as soon as these and connected problems can be solved. Their solution should only be a matter of time and research.

Numerous alternative methods have been suggested for the mechanical manufacture of shellac and numerous patents have been registered. Puran Singh suggests the use of wood spirit (methyl alcohol) as an alternative for methylated spirit (ethyl alcohol) and brings forward sound arguments in favour of its use. Other investigators suggest solution in an alkali, filtration, and precipitation with an acid, or the use of centrifugal force to filter molten lac directly from its impurities. Their success has yet to be established.

The By-products of Shellac Manufacture.

Kiri or *Phog* is the refuse remaining in the bags after the shellac has been squeezed out. It is a black and sticky mass and is pressed while still warm into cakes about one inch thick and eight to ten inches in diameter. It consists of animal remains, fibre and woody material, with a large proportion of lac resin and a considerable quantity of lac-wax. It is worked up in different ways:—

(1) *Kiri* from the manufacture of high grade shellac is mixed with stick-lac and used in the manufacture of TN.

(2) It is bought by machine manufacturers in India and abroad and used for the manufacture of garnet lac by the alcohol process.

(3) It is used in local Indian industries; principally the manufacture of bangles and toys.

Shellac should always be stored in a cool dry place and it is advisable that it should not be shipped during the extreme hot weather and rains, when there is always a risk of its arriving in a set or "blocky" condition. An allowance is made to the importer for blocky shellac, to cover the additional cost of having it freed.

CHAPTER IX.

MANUFACTURE.—PART II.

Manufacturing centres

Mirzapur has always been and is still the home of shellac manufacture. Indeed, practically the whole manufacturing industry used to be concentrated at Mirzapur, which before the days of railways was a convenient centre for the collection of stick-lac by road from the principal producing areas, and for the despatch of shellac by river to Calcutta. With the development of railways, however, the importance of Mirzapur has declined. It is awkwardly situated from the point of view of rail transport, for it lies outside the direct route leading from the main stick-lac markets to Calcutta In future, it is likely to become gradually a manufacturing centre of minor importance, working up lac from the United Provinces, the Punjab and Hyderabad (Sind). The following figures illustrate the decline in the importance of Mirzapur as a manufacturing centre :—

Year	INDIA'S TOTAL PRODUCTION.			
	Imports of stick-lac into Mirzapur	Calcutta export in cases of 2 maunds.	Equivalent in stick-lac maunds	Percentage of total stick-lac production which was manufactured in Mirzapur
	Mds.	Mds	Mds.	Per cent.
1901—1905 ..	1,03 ,000	699,500	2,798,000	37
1906—1910 ...	1,7 ,000	1,197,000	4,788,000	35
1914—1918	996,000	1,103,500	4,414,000	25

After Mirzapur and Calcutta the principal centres now are, in order of importance,—

Balarampur ..	Manbhum District.
Jhalda .	Manbhum District.
Pakaur . ..	Santhal Parganas
Imamganj .. .	Gaya District.
Umaria . .	Rewah State.
Ranchi ..	Ranchi District
Bundu	Ranchi District

In addition to these, there are small centres at Gondia (C. P.), Chakardarpur (Singbhum), Chandel (Manbhum), Purulia (Manbhum), Daltonganj (Palamau), and Mailhar (C. I.), and small factories frequently appear and disappear in any small town or village in the lac areas. The production of lac has developed faster in Bihar and Orissa than in the Central Provinces. In fact Bihar and Orissa is now capable of manufacturing the whole of its raw lac and imports large quantities from the Central Provinces. Manufacture in the Central Provinces has hitherto developed very little, and the stimulus recently given to lac cultivation in those Provinces should be turned to useful account by local manufacturers. Almost any railway station on the Bengal-Nagpur broad gauge line would seem to provide a suitable locality for a factory The climate is dry during the greater part of the year and the manufacturer will only need to consider the question of water-supply and labour. Raipur in particular is very close to a large Kusum supply area at Rajim and Dhamtari ; it is in easy communication with Gondia, Katni (including Damoh) and Pendra, all large Baisakhi and Katki markets, and is only a few miles further from Calcutta than is Mirzapur. Labour is plentiful and cheap though skilled labour must, of course, be imported from Mirzapur until local labour can be trained.

Grades

The bulk of the shellac manufactured is known as *TN*. This mark is a standard of the trade and is non-proprietary. It has been in existence for a long time—so long indeed that its origin cannot now be accurately traced. The following derivations have been suggested, the first of which is the most probable :—

(1) That it was originally the mark of Taluram Naturam, manufacturer of Belarpur.

(2) That it was originally the mark of Triloki Nath, Bengali.

(3) America suggests that it stands for "Truly Native" This seems very unlikely.

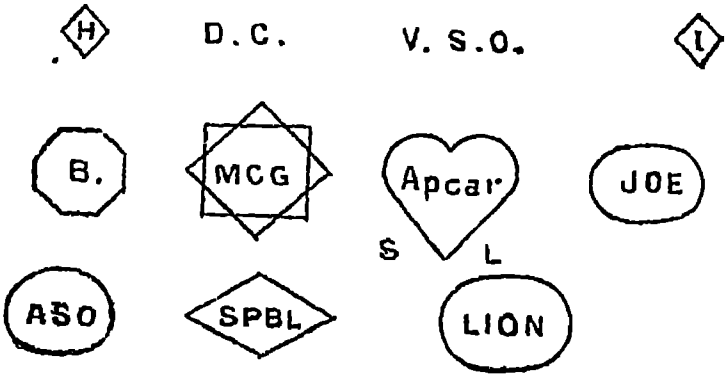
Though it is a universally recognized standard the quality of TN is not fixed, but varies from year to year with the quality of the stick-lac crops from which it is manufactured ; and the London market makes its own standard each year from the first few shipments TN as such is pure shellac with a limit of 3 per cent insoluble impurities. It contains no rosin. Rosinous shellac is sold

as such and is manufactured to contain 10 to 12 per cent. rosin. Calcutta brokers blend this with pure TN to make a 3 per cent. mixture which is a standard in London. The quality clause in the standard form of contract adopted by the London Shellac Trade Association runs as follows :—

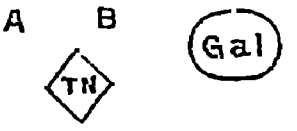
"Guaranteed to be of equal value to standard sample of TN and not to contain more than 3 per cent. of adulterating matter or if inferior thereto a fair allowance to be made." Similarly, the New York market recognizes "ordinary pure TN" which must, however, be free from rosin ; but has established, in addition, a grade known as "Ussa TN" containing 3 per cent. of rosin.

Superior to TN is Standard I, another non-proprietary mark. It is only a clean grade of TN and differs from it in no other essential except a slightly better colour and fewer impurities. It contains no rosin, and fetches three to five rupees more than clean TN. TN and Standard I are manufactured only from Baisakhi and inferior lacs, and not from Kusmi. The better Baisakhi is used for Standard I while poor Baisakhi, Katki and rejections from fine grade manufacture are used for TN. The bulk of the TN and Standard I is made in small factories. The larger factories usually make better qualities and only make TN when they cannot get good stick-lac or wish to use up their rejections.

Superior to Standard I are the "Fines" and "Superfines"—practically all proprietary marks. They are usually manufactured from the very best Baisakhi lac with or without a proportion of Kusmi, while the very finest grades are made from pure Kusmi. The following are well-known marks of this class, as quoted by Messrs. Moran in their weekly statement :—



The Calcutta market will not accept machine-made shellacs as TN. They are therefore made and sold as proprietary marks. The marks quoted by Messrs. Moran are—



Angelos' TN

Angelos' TN No. 2.

Bleached shellac, though not exactly a separate grade, is a special form of shellac used in making white varnishes and for other purposes in which a white colour is required. There are various methods of preparation which are described by Puran Singh, usually a reducing agent is employed of which chlorine is the commonest. Bleached shellac rapidly loses its solubility unless kept under water and it must therefore be made immediately before use. Its manufacture in India for export is thus hardly a practical proposition

Shellac inferior to TN is known as "*dom*." It is not generally recognized as a definite grade but is bought and sold at a discount on the current rate for TN. A notoriously poor class of shellac is manufactured at Imamganj, and the use of the term "Imamganj" has now broadened so as to cover any inferior TN.

Button lac is sold at a lower price than shellac of the same grade, as it does not go through the process of stretching, and hence the cost of manufacture is less. It is not so popular in foreign markets, as it has generally to be ground before use. There are roughly four grades :—

(*a*) Pure Button lacs made from good grain-lac and graded up in values from the equivalent of Standard I shellac to that of D.C.—V S.O.—Octagon B

(*b*) Pure Black Button lacs made from *kiri*, *molamma*, etc., and sold at about TN prices.

(*c*) Button lacs made from good grain-lacs, but containing 20 to 30 per cent. of rosin and sold in various grades, some cheaper others dearer than TN.

(*d*) Black Button lacs made from *kiri*, *molamma*, etc., but with rosin admixture and sold much below TN rates.

Garnet lac is usually of inferior quality containing 10 to 12 per cent. of rosin and has also to be ground before use. The principal marks quoted by Messrs. Moran & Co. are—

The consumers of shellac in the U. S. A. have advocated the creation of a definite series of official grades of shellac, to which manufacturers should be asked to approximate their marks. This proposal does not meet with the approval of the better class manufacturers in India as the individuality of their marks would be lost and with it the premium now paid for consistent quality. Further the speculation in shellac, now confined to TN and Standard I, would be extended to all grades. The larger the number of private marks manufactured, the less is the tendency to speculation. No true speculator dare now offer a high grade shellac unless he has the full quantity actually in his godown, in which case the business is scarcely speculative; for he has only one source of supply, namely, the actual manufacturer of the particular grade. If the standards of high grade shellac are official, any one will be able to manufacture them and the speculator will be tempted to gamble in them.

The costs of manufacture.

Prior to 1914 the actual cost of TN manufacture was about Rs. 7 per maund, but since the war prices have risen considerably and the following may be taken as about correct:—

	Rs	a.	p.
Crushing, sifting and washing to convert the stick-lac into grain-lac	1	8	0
Cloth for bags	2	8	0
Thread for bags	0	4	0
Labour (at the fires)	3	0	0
Charcoal	1	8	0
Orpiment	0	4	0
Soda for boiling bags	0	4	0
Fuel for boiling bags	0	4	0
Total	9	8	0

The cost of manufacturing TN is therefore about Rs. 10 per maund. It will be noticed that no account has been taken of overhead charges or of interest on capital. The bulk of the TN is

manufactured in small factories where the owner is either himself a workman or personally supervises the work. The cost of the *nands*, stoves and other implements is so small that the eight annas added above to make the round figure Rs. 10 more than covers the interest on capital expenditure. The large manufacturer certainly employs highly paid supervising staff, but his outturn is so large that the actual incidence per maund is small and his expert supervision enables him to produce shellac of high quality, the extra value of which more than covers the cost of expert supervision. The cost of manufacture can therefore be fairly estimated at an average of Rs. 10 per maund of shellac.

And now with regard to the raw material The quality of stick-lac varies so much that it is always sold and bought on an estimate of the amount of *biuli* lac or of grain-lac which it contains. The former is clean stick-lac free from twigs and dirt, the latter has already been described in the preceding chapter. Both *biuli* and grain-lac give a known and constant yield of shellac to the manufacturer, the chief variations are those due to quality or season. The following are the calculations commonly adopted in conversion :—

Biuli Lac.

One	maund	Kusmi	ari	yields	32—33	seers	grain lac.
,,	,,	Jethwi	,,	,,	31	,,	,,
,,	,,	Baisakhi	,,	,,	26—28	,,	,,
,,	,,	,,	Phunki	,,	30	,,	,,
,,	,,	Katki	ari	,,	16—20	,,	,,
,,	,,	,,	Phunki	,,	26—28	,,	,,

Grain-lac.

One maund Baisakhi or Katki grain-lac yields 30 seers of shellac.
,, ,, Kusmi or Jethwi ,, ,, 36 ,, ,,

Of course in the more careless methods of TN manufacture the inclusion of dirt, grit, etc, in the shellac will increase the yield. TN is, however, rarely made only from stick-lac; *kiri*, *molamma*, and *passewa* are nearly always included in the formulæ.

As the value of shellac is always fluctuating the manufacturers use calculating tables which show the price they can afford to pay for stick-lac against each Calcutta TN quotation

In the case of many manufacturing industries, the bulk of the manufactured goods are sold forward, often over periods of weeks or even months. The manufacturer bases his quotation, firstly, on

current prices of the raw material and finished article, and, secondly, on an estimate of the future trend of these prices. His profit will depend on his being able to secure a satisfactory margin between the price of the raw material and the price secured under his contract for the finished goods. The manufacture of shellac is an industry of this class. As already shown, the stick-lac markets are highly speculative. To some extent stick-lac quotations follow the course of Calcutta TN prices, but they naturally fluctuate to a greater degree than TN, chiefly because the extent of forthcoming supplies cannot be even approximately estimated in advance; and hence the future trend of the TN market is the subject of the wildest guess-work. Even the manufacturers of private marks are misled in their estimates and postpone their purchases of stick-lac too late or purchase too early against forward sales of their marks. Still more is this the case with the manufacturers of TN, who are usually men of small means in the hands of big local dealers. They depend entirely for success on attempts to estimate accurately the forward trend of stick-lac and TN rates; and too frequently they are caught short of their raw material which they are compelled to purchase at a disadvantageous time, forcing up prices against each other. Chart No. I compares fluctuations in the prices of stick-lac and TN during 1912 and 1913, and illustrates the wide fluctuations of the former in comparison with the latter.

The solid line represents the cost of stick-lac required to make one maund of TN shellac, to which is added all charges for manufacture and marketing in Calcutta; the table on the chart shows how these figures were obtained. The monthly prices of stick-lac were supplied by a Calcutta manufacturer and, to ensure accuracy, the exact factors for conversion on which he based his *biuli* prices have been used (Note that the lac is *ari*, not *phunki*). The interrupted line shows the price one maund of TN actually fetched in Calcutta The two lines continually cross and recross one another. When the TN (interrupted) line is above the solid line there is a manufacturing margin of profit. When the solid line is above the interrupted the manufacturer who buys his stick-lac and sells his shellac on the same day must lose. The double and single shading on the chart show respectively periods of loss and profit on manufacture and spot sale.

It will be observed that, during the whole of 1912, Calcutta TN prices were low, from chart No. II the cause is seen to be the large stocks held in London At the same time supplies of stick-lac were ample, and manufacturers, therefore, had matters much their own way, with the result that practically throughout 1912 there was a small manufacturing margin of profit and Calcutta prices fluctuated very little. In 1913 conditions changed. The stick-lac crop was poor, and this factor, combined with a slight decrease in the London stocks, caused a big advance in Calcutta prices. TN prices fluctuated considerably and owing to the shortage of the crop the stick-lac prices fluctuated even more violently, with the result that the interrupted line is, more often than not, below the solid line, showing that spot sales did not yield a profit.

The first step required to stabilize the trade is to ensure a steady supply of stick-lac and the second is to provide an early and reliable forecast of each crop. A tour of the stick-lac districts makes it quite clear that increased production is more feasible than has hitherto been supposed. In fact it is not unlikely that Manbhum or Ranchi districts alone, if they produced their largest possible outturn of stick-lac (an unattainable ideal), could provide the whole of the world's requirements. At present the total Indian supply is, more often than not, less than the demand. The action Government can take with the object of regularizing supply may be direct or indirect. The direct method is by developing lac cultivation in the extensive Government forests. This has begun in the Central Provinces where departmental work has already trebled the supply in Damoh. The Local Government is extending this work to other districts and is appointing a special staff including a special department for research. In view of present scarcity conditions in the foreign markets there can be very little fear of over-production for some years to come. The indirect method of Government action is twofold. firstly, the formation of brood and demonstration farms throughout the lac districts, as advocated in Chapter IV. The importance of these farms cannot be too strongly emphasized. Secondly, much good would result from the publication of authoritative periodical reports on the crop, based on the experience obtained in Government forests These reports need not at first give quantitative estimates but should show in some detail the effects of climatic conditions.

Another point that may be brought to notice is that Government should do everything possible to encourage the production of the better qualities of lac. With this object in view the propagation of Kusum lac might be encouraged in preference to other varieties where the choice can be made; and, after Kusum, of Ber and Ghont lac. If high grade stick-lac is available the production of high grade shellac will increase at the expense of TN; the paramount influence of TN on all markets will decrease and with it the tendency to speculation.

CHAPTER X.

INTERNAL TRADE OF INDIA.

Stick-lac Markets

The distribution of lac cultivation in India has already been described in detail. It is not often realised how scattered cultivation is, how wide the total area; and in some cases how scanty and difficult are, means of communications. A very high proportion of the whole area consists of jungle tracts from which the cultivators bring the stick-lac often long distances by road or river to the nearest bazaar, which is not itself necessarily situated on or even close to a railway.

The following is a list of the principal stick-lac markets of India with an estimate of the crops arranged as Kusmi, Jethwi, Baisakhi and Katki The names of the districts are those in which the markets are situated, and not necessarily those in which the lac is grown. Thus Imamganj is situated in Gaya district, but much of the Imamganj lac comes from Palamau and Hazaribagh districts; Jhalda is in Manbhum district, but perhaps one-half of the Jhalda lac is grown in Ranchi and Hazaribagh districts. The estimates are very rough and can have no pretensions to accuracy. They do not represent bumper crops but merely crops secured during good average years:—

Province	District	Market	Crops in maunds				
			Kusmi	Jethwi	Baisakhi	Katki	Total
Bihar and Orissa	Manbhum	Balarampur	12,000	5,000	25,000	10,000	52,000
		Jhalda	25,000	8,000	45,000	16,000	94,000
		Chas	..	..	10,000	5,000	15,000
		Manbazar	..	..	20,000	6,000	26,000
		Katras	..	..	2,000	1,000	3,000
		Gobindpur	..	..	2,000	1,000	3,000
	Ranchi	Ranchi Bundu Lohardaga Khunti Managhatta	20,000	10,000	35,000	20,000	85,000

Province	District	Market	Crops in maunds.				
			Kusmi	Jethwi.	Baisakhi	Katki.	Total.
Bihar and Orissa	Hazaribagh.	Chatra ..	5,000	2,000	20,000	10,000	37,000
		Hazaribagh ..					
	Gaya	Imamganj			40,000	20,000	60,000
	Palamau	Daltonganj	...		30,000	15,000	45,000
		Garhwa ..	3,000	1,500	40,000	20,000	64,500
	Saran ...	Chapra and other small markets	..		2,000	1,000	3,000
	Sonthal Parganas	Pakaur, etc		.	75,000	20,000	95,000
		Dumka ..	.		2,000	1,000	3,000
	Singhbhum	Chaibassa ...	15,000	10,000	30,000	25,000	80,000
		Chakardarpur .					
		Gamaria					
		Tatanagar, etc					
	Sambalpur	Jharsaguda	1,000	500	2,000	1,000	4,500
		Sambalpur ..					
		Rajgangpur (O. F. S.)					
Central Provinces.	Bilaspur	Pendra including Bilaspur ..	2,000	500	20,000	10,000	32,500
		Champa, Sakti					
		Raigarh (O.F.S.)					
		Akaltara, etc.					
	Raipur	Rajim ...	20,000	10,000	2,000	2,000	34,000
		Dhamtari (including Balod) ..	10,000	5,000	1,000	1,000	17,000
	Bhandara	Gondia includes Balaghat ...	.	..	40,000	50,000	90,000
		Mandla .					
		Seoni ..					
		Chhindwara ...					
		Chanda ...					

Province.	District.	Market.	Crops in maunds.				Total.
			Kusmi	Jethwi	Baisakhi.	Katki	
	Damoh	Government Forests ..	.	...	500	4,500	5,000
	Jubbulpore	Katni	600	300	25,000	10,000	35,900
		Sihora .	.		5,000	2,000	7,000
		Jubbulpore	600	300	6,000	4,000	10,900
	Hoshang-abad	Bankheri	3,000	2,000	2 000	1 000	8,000
		Itarsi including Narsinghpur					
United Provinces	Mirzapur	Ahraura			5,000	2,200	7,200
	Bahraich	Mathara & Rissia	.		2,000	3,000	5,000
	Aligarh	Hathras ..	..		1,000	1,000	2,000
	Lucknow	Lucknow .			1,000	1,000	2,000
	Kheri	Singhri ..		.	2,000	2,000	4,000
	Cawnpore	Cawnpore .	...	.	1,000	1,000	2,000
	Saharanpur	Saharanpur ..	.		3,000	2,000	5,000
	Bareilly	Bareilly	..	...	3,000	1,000	4,000
Punjab ...	Hoshiarpur	Hoshiarpur Una	...	.	15,000	10,000	25,000
	Rest of the Punjab	.	..	.	5,000	3,000	8,000
Central India	Rewah Ste	Umaria ..	1,000		30,000	20,000	51,000
	Esociet	Maihar	...	..	4,000	2,000	6,000
	Bhopal	Bhopal ..		.	2,000	1,000	3,000
Bombay	Sind	Hyderabad, etc	...	..	20,000	6,000	26,000
	Rest of Bombay.	...	.	.	1,000	1,000	2,000
Burma				.	20,000	10,000	30,000
Assam		..			20,000	15,000	35,000
			118,200	55,100	616 500	337,700	1,127,500

The total production may thus be estimated at over a million maunds of stick-lac, of which each cultivator is usually responsible for not more than a few seers.

Lines of Stick-lac Trade

As a result of these conditions—the scattered character of the industry and the long distances by cooly, cart or boat, as well as by train, to the important markets—the crude stick-lac has to pass through many hands on its way from the cultivator to the factory. The organization required for this trade is very complicated. Its outposts consist of a large number of stick-lac markets which are really centres of collection in more or less close touch both with producing areas on the one hand and with manufacturing centres on the other. But this trade does not follow any very clearly defined routes, for stick-lac will be attracted to different markets from one season to another and will be passed on at all seasons to any one or more of the manufacturing centres. No history of the internal trade of India would be complete without some account of the agents who carry it on. The following are the principal links in the chain :—

The first agent is the cultivator or *raiyat* on whose efforts rests the whole fabric of the lac industry of India. As already described the cultivator is normally a person of poor education and small means who cultivates an acre or two of land on lease from a zamindar. His holding may include a few trees suitable for the production of lac; or he may take a lease of suitable trees on uncultivated lands outside; or again he may act as an employee of the zamindar himself or of a contractor dependent on the zamindar. There is this difference, however, between the lac industry and agricultural industries proper, that whereas the latter are staple industries, the former merely provides the cultivator with subsidiary earnings to supplement those obtained from agriculture. A natural consequence is that the lac industry as a whole tends to be quickly affected by factors which would not affect a staple industry. When the price of lac is low trees may be neglected and production may fall off comparatively quickly; and production may be similarly affected through the indolence of the cultivator if the agricultural season is good and he is obtaining full prices for his field crops. It thus happens that the margin of production in the case of lac is considerably wider and more elastic than is usual in the case of agricultural industries proper. An expert in local conditions of the industry would be able to draw a series of concentric rings round any important bazaar, and to describe roughly the relative distances from which lac will

be worth collecting and bringing to market at different levels o price.

The next link in the chain is the *Baipari*, a wandering trader equipped with a cart or a few pack bullocks, who wanders from village to village selling salt and other commodities and buying up local products of which lac is one His methods of business are many and vary according to the class of person with whom he is dealing. With the aboriginal living in the depths of the jungle his dealings are generally in kind, so many seers of salt or other commodity being given in exchange for lac. Naturally the Baipari with his general knowledge of market prices always gets the best of the bargain. In his dealings with the more sophisticated cultivators, the bargaining is usually for cash and is much closer, as there is more competition and the seller has more opportunity of learning the trend of events in the markets. The Baipari is usually a man of small means and is frequently financed by the Arhatiya, who retains a lien on the lac and has the right to arrange for its sale.

The centre of the whole system of up-country distribution is the *Arhatiya* or *Ardar*, the commission agent or broker. He is usually a man of substance, shopkeeper, money-lender, agent and auctioneer, and lac-broking is generally only one of his many activities. He is purely an agent and never actually owns the lac which passes through his godown, but sells it on commission. He takes commission from the seller at a percentage of the price obtained, usually about 1 per cent, and from the buyer at so much per maund of lac bought, usually about Re. 1 His remuneration seems high but he acts as surety for the buyer, and if the latter fails to pay up the Arhatiya is responsible to the seller for the value of the lac. When selling to firms of well-known standing, he frequently reduces his commission considerably below the rate he would ask from dealers of doubtful financial stability.

The method of sale differs in different districts. Sometimes it is open auction, when the purchasers will inspect the lac offered by the Arhatiya, make their own estimates of its value and bid accordingly. Another and very common method is the cloth method of secret auction. The Arhatiya, the seller and the buyers all sit in a ring round the lac to be sold. Each extends his right hand into the middle of the ring; the hands are covered by a cloth, and bids are

made to the Arhatiya by signs under the cloth. The Arhatiya then by similar signs conveys particulars of the highest bid to the seller, who agrees or not to the sale. The signs are by the fingers and the value of a finger depends on the rates at which lac is being sold at the time. If prices are in the neighbourhood of Rs. 40 per maund, the offer is conveyed by two grasps. The first will intimate the tens, each finger grasped representing Rs. 10. At the second grasp, each finger joint represents one rupee. For example, if a buyer wishes to bid Rs. 35 he will grasp the first three fingers of the Arhatiya's hand to show Rs. 30 and then the whole of the first finger to show Rs 3 and two joints of the second finger to show Rs. 2. When the sale is completed, the Arhatiya signifies the fact by whipping away the cloth and throwing a handful of lac into the lap of the successful bidder.

The purchasers of lac may be agents of large manufacturers who are paid a small retaining fee and a commission on purchases effected More usually they are dealers, frequently Marwari by caste, who buy up the lac as a speculation and take it to the manufacturing towns, retailing it to the small manufacturers as required. The dealer is generally a man of substance, and at first sight appears to be a mere parasite of the trade. Were this a fact, he would rapidly disappear as the lac trade is very keenly competitive and no true parasite could survive the operations of a single season. The *raison d'être* of the dealer is not far to seek. The majority of the manufacturers are small men of little capital, who cannot afford to send agents to the stick-lac markets. Further, the lac harvest is reaped during comparatively short periods of each year and the small manufacturer is rarely able to buy sufficient to last him until the next crop comes in. This is where the dealer's intervention is essential. He buys lac as an investment and doles it out to the manufacturer as soon as the latter has converted earlier purchases into shellac, sold the shellac, realized the price, and is thus in a position to buy again. A further advantage in the case of a commodity of values so fluctuating as those of lac is the dealer's participation in the risk. The dealer undoubtedly plays an important part in the financing of the industry and is honourably entitled to his share of the profits.

Each crop takes as a rule two months to pass completely through the markets. The speculative element is strong, for any given consignment of lac may change hands several times up-country before

it reaches the Arhatiya and again in the manufacturing centre before it reaches the manufacturer. On the other hand the large manufacturers and large cultivators aim at eliminating as many as possible of the middle-men. For example, most of the important manufacturers employ agents to purchase on their behalf at each of the big markets, and those agents again employ sub-agents to purchase in the districts. The agent buys as best he can, direct from the Baipari, or through the Arhatiya, and his sub-agent in a large measure replaces the Baipari. He is daily informed, by wire from his head office, of the quantities and qualities required and the prices he may pay. Occasionally an Arhatiya will take up an agency on behalf of a manufacturer. It should be remembered, however, that the number of manufacturers who are able to adopt these methods is comparatively small, and that the bulk of the lac passes through the ordinary channels. The price of stick-lac in Indian markets thus follows very closely the Calcutta prices of TN shellac, and fluctuates as local forecasts of the trend of the Calcutta market are more or less optimistic.

Lines of Shellac Trade

In the internal lac trade of India, the chief interest centres in the innumerable transactions which cover the journey of the crude lac from the tree to the factory. The transit of the finished article, orange, garnet or button lac, from the factory to the port is less eventful. It follows more ordinary lines of trade and can be described in a few words.

Practically all up-country shellac is attracted to Calcutta for export; the export trade from Bombay, Karachi, Madras, and Rangoon is negligible. Between the up-country manufacturer and the Calcutta merchant-shipper, who undertakes the actual shipments to foreign countries, stands in some cases a dealer, in some cases a broker and sometimes both. The Calcutta dealer is naturally a man of bigger standing than the up-country dealer. He is often a Marwari with considerable capital at his back, handling other produce besides shellac. He has agents in the manufacturing centres who purchase shellac and rail it to Calcutta on his account. In some cases also he purchases locally from the Calcutta agents of the better class of up-country manufacturers. By this means he may accumulate considerable stocks in Calcutta which he will sell, when the market is favourable, to the brokers or to the merchants or to other dealers.

He may, of course, act as a commission agent and secure supplies for a principal; but, in most cases, the shellac is his own property, of which he disposes at the highest available rates.

The broker on the other hand works, in theory at any rate, purely on a commission basis. He also has his agents in up-country markets and thus keeps in touch with forthcoming supplies and their prices. He visits the offices of the principal shippers, ascertains their requirements, with particulars of quantity, quality and price, and closes the business on offers received through his up-country agents.

The shipper is usually a merchant of good standing with principals or agents in London, New York and other foreign markets. Three-quarters of the export trade is conducted on the basis of "forward delivery" contracts, and the quality is then guaranteed to a type such as TN, St. I, etc. So far as spot goods are concerned, the merchant purchases on samples brought to him by the brokers or dealers and is influenced chiefly by the lightness of the colour in estimating the value of a consignment. He will also, to be on the safe side, secure from a local analytical chemist a certificate showing on analysis the percentage of rosin admixture or the freedom from rosin. The class of business preferred is naturally that wherein a definite offer is received by cable from London or New York, which can be accepted if shellac is available at a suitable price or rejected if it is not. The profits in this business are rarely high, but they are certain. In the alternative, offers may be cabled to London or New York firms for acceptance or refusal. Or, again, shipments may be made to London or New York agents for consignment sale if the trend of prices in the foreign market seems favourable.

Local industries.

The local industries of India at present employing lac as a raw material are not numerous, but there is no reason why these local demands should not increase. Imitation fruits and toy animals are made of lac, or of wood coated with lac The Indian toy trade is still in its infancy, but steps are being taken by the Commercial Intelligence Department of Calcutta, in conjunction with Directors of Industries in India and with the Indian Trade Commissioner in London, to interest foreign markets in Indian toys. Bangles are manufactured from *kiri*. Gramophone records are turned out in

large quantities in Calcutta. The manufacture of crude micanite, from alternate layers of mica splittings and shellac, has been started at Kodarma, an important mica centre, and should progress to the manufacture of the finished article. A considerable quantity of shellac is also used in the manufacture of Indian paints, varnishes and sealing-wax. Finally there seems to be no reason why India should not manufacture and export lac-wax, a hard white wax suitable for polishes, and a successful rival to canauba wax. At present, however, the proportion of lac required for industrial purposes in India is small in comparison with the export trade.

Speculation

There have been so many complaints in foreign markets as to the speculative character of the shellac trade, the number of unnecessary middlemen in India and serious fluctuations of Indian prices, that the subject calls for special comment. Speculation must be frankly admitted. But very few of our foreign critics realize the peculiar circumstances of the industry, on which it is hoped that the present chapter will have thrown some light. Some 80 million pounds of stick-lac are collected during two principal seasons of the year from centres so far apart as Hyderabad (Sind) in the west, and the Shan States in the east. On the average, no single cultivator is responsible for more than a few pounds of this enormous total, and each quota must pass through many hands before it finally reaches the manufacturing centres on the East Indian and Bengal-Nagpur Railways, from which the finished product is railed to Calcutta Although the expenses of propagation and again of manufacture are not high, the expenses of collection are considerable ; and in the very nature of the case the risks must be distributed amongst a large number of agents, chiefly men of small education and less means. As the next chapter will show, the foreign demands for shellac are keen and increasing, and Calcutta is practically the only source of supply. At the same time, estimates of forthcoming crops are, also in the very nature of the case, extremely difficult to make , indeed from the total available quantity is never really known until all has come in.

While the extent of forthcoming supplies is so uncertain the extent of the foreign demand is more easily gauged Every increase or decrease of London stocks, qualified by up-to-date information as to shipments, is an indication of the weakness or strength of the

demand. Chart No. II illustrates the close relation between London stocks and Calcutta prices, which rise as the stocks decline and fall as they expand.

As London stocks through the medium of London prices affect the Calcutta TN rate, so do Calcutta rates affect the prices paid up-country for lac entering the stick-lac and manufacturing markets. These markets are in close telegraphic communication with Calcutta, and every fluctuation in the Calcutta prices gives rise to up-country estimates of fluctuations to follow.

Fluctuations in the Calcutta TN rate are thus due chiefly to the inter-action of demand and supply in foreign markets, which are handicapped, moreover, by uncertain information as to the volume of forthcoming supplies. Speculation is bound to flourish in this atmosphere. It may, and certainly does, accentuate the fluctuations of price of which, however, it cannot be described as the primary cause. As education spreads, the disturbing factors will undoubtedly diminish, but this is a matter of time. The more direct remedies suggested, the departmental propagation and distribution of brood-lac and demonstration of improved methods, the preparation and distribution of accurate crop forecasts, the organization of research work and publication of results should undoubtedly contribute to steady the trade.

CHAPTER XI.

FOREIGN TRADE.

General

The following table gives particulars of the Indian export trade in shellac, garnet and button lac since 1901 Packing is either in cases or in double gunny bags containing two maunds or approximately 1½ cwts. each. - This unit has been adopted and for convenience round figures have been given :—

Exports of Shellac, Garnet and Button Lac in cases of 2 mds. or 1½ cwt.

	1901	1902	1903	1904	1905	1906
United Kingdom .	35,500	59,500	65,500	79,000	42,000	38,500
U. S. A . ..	45,000	48,000	55,500	52,500	73,500	82,500
France ..	5,500	1,500	4,000	3,500	7,000	2,500
Germany ...						
Holland and .	22,500	14,500	19,000	17,500	30,000	28,500
Austria ..						
Japan ...						
Other Countries ..	3,000	3,000	3,000	4,500	5,000	4,500
Total ...	111,500	126,500	147,000	157,000	157,500	156,500

	1907	1908	1909	1910	1911	1912	1913
United Kingdom .	55,500	65,000	72,500	83,000	50,500	50,000	53,000
U S A .	84,500	79,000	155,000	118,000	91,000	111,000	94,000
France ..	7,500	10,500	9,500	15,500	11,500	16,500	9,500
Germany							
Holland and	52,500	59,000	72,000	64,000	66,000	63,500	27,500
Austria							
Japan							
Other Countries	7,000	8,500	12,500	9,500	16,000	13,000	8,500
Total ...	207,000	222,000	321,500	290,000	235,000	254,000	192,500

	1914	1915	1916	1917	1918	1919
United Kingdom .	54,500	58,000	46,000	40,000	58,000	56,000
U S. A.	114,500	161,500	154,500	142,500	108,000	139,000
France .	8,000	10,000	6,500	500	6,000	5,450
Germany ...	35,000	..	..	.		450
Holland and						
Austria .						
Japan	2,500	6,500	10,000	8,500	12,500	600
Other Countries ...	17,000	7,500	19,000	4,500	12,000	3,500
Total .	231,500	243,500	236,000	196,000	196,500	205,000

It will be observed that the United States of America are by far the best customer. Exports to the Continent were chiefly on account of Germany, not merely for her own requirements, but also for re-export to Russia and other neighbours. Trade with the Continent naturally fell off during the war, and shows little sign of recovery at present. During 1919 200 cases of orange shellac were shipped to Hamburg and 250 to Rotterdam.

Before the war, the purchases of the United Kingdom were increasing, but largely for re-export to other countries. The above statement does not, of course, give a true indication of the relative consumption at destination. The United States of America and the United Kingdom are now India's best customers and the following figures give a more accurate indication of the relative consumption in these two countries respectively :—

Average annual consumption of shellac.

During the five years preceding the war (1909 10 to 1913-14)	During the five subsequent years (1914-15 to 1918-19).
Cases.	Cases.
U. K 38,000	39,000
U. S. A .. 119,000	140,000

The consumption figures for the United Kingdom have been arrived at by deducting from the imports during each period the

re-exports during that period, and then adding or subtracting the amount by which stocks decreased or increased For example, during the earlier and latter periods of five years, imports less re-exports averaged 48,000 and 24,000 cases, respectively. During the earlier period, however, stocks had increased from 50,000 to 100,000 cases, and the allowance for these additions to stock reduces the average consumption from 48,000 to 38,000 cases. During the latter period stocks declined from 100,000 to 25,000 cases, and the allowance for this depletion raises the average annual consumption from 24,000 to 39,000 cases. Figures representing stocks in the United States of America are not available, and the consumption figures given above show merely the average imports into the States less the average re-exports during each period.

The total export trade in shellac has increased materially during the 19 years under review. Naturally, as London stocks have their effects on London and Calcutta prices, so also the prices affect production. Unfortunately, accurate figures of production are not available, but local consumption in India, which is confined largely to *kiri*, is, such as it is, fairly constant, and may be neglected. Moreover supplies cannot be held up long in India for fear of "blocking" in the Indian summer and rains. And thus the total volume of exports during any year is a safe indication of the total production during that year.

During the first four years of the period, from 1901 to 1904, foreign demands increased materially. Although statistics of the gramophone trade are not recorded in the Official Customs returns of the United States until 1909, it is an undoubted fact that large and increasing quantities of shellac were being used for gramophone records before that year. The demand on account of electrical apparatus was also increasing. Hence the rise in exports from 111,500 cases in 1901 to 157,000 in 1904 By 1905 London stocks had increased materially. Prices sagged and the trade did not expand during 1905 and 1906 By 1907 stocks were low and prices very firm, resulting in a large advance in production and exports, from 207,000 cases in 1907 to the enormous total of 321,500 cases in 1909, a record which has never since been exceeded. During these years, however, London stocks were gradually built up again, and even the ensuing decline in prices and exports did not result in

any material reduction of stocks, which stood at between 90,000 and 100,000 cases during the five years 1911—15.

The decline in exports was arrested by the outbreak of war, and during the war they averaged over 200,000 cases. By 1918 stocks were gradually depleted in the European markets, and although munitions stocks were fairly high, these did not suffice for commercial purposes when peace was declared. The consuming industries of the United Kingdom and America were in urgent need of shellac, and the result was a general scramble for supplies, for which almost any price was paid. Unfortunately, both the 1918 and 1919 crops were short in India and the stringency was thus accentuated It is a significant fact that the absence of Germany as a rival purchaser has not been noticed. Fortunately, the 1920 crop promises well. It will be interesting to see if, in view of the keen demand, the record export of 1909 will again be reached.

Foreign Demands

In Chapter VIII have been described the various processes employed for the preparation of lac for the market. A very small proportion is exported in the crude form of stick-lac, and it is unlikely that this proportion will increase materially, partly because it involves the payment of ocean freight on sticks, dust and other impurities naturally adhering to lac, and partly because manufacture in India is cheap. A small proportion is also exported in the partially prepared form of grain-lac, and as garnet and button lac. Orange shellac constitutes the vast bulk of the exports The proportions in which the different classes are required in foreign markets have developed in favour of shellac as the following figures show .—

Proportional exports of	During four pre-war years (average of 1911 to 1914).	During four years (average of 1915 to 1918)	During 1919.
Shellac	82·1	87·0	89·6
Garnet lac	7·3	5·6	5·7
Button lac	5 8	1·4	3 1
Grain-lac	3·4	5·0	1·1
Stick-lac .. .	1·4	1·0	5

From time to time the suggestion has been made that the export trade could be conducted more cheaply and more efficiently in the form of grain-lac. Shellac appears, however, to be the most suitable form from the point of view of foreign manufacturing industries requiring pure lac. It is true that a large proportion of these industries require that lac shall be dissolved before use, and that the impurities, normally present in grain-lac, can then be strained off. But conversion into shellac reduces these impurities to a minimum, and facilitates the appraisement of colour. Moreover it is believed that the natural resin and wax are not intimately mixed in grain-lac which has not therefore the important property of a good flux, required by gramophone record and other manufacturers using lac in powdered form and not in solution Finally grain-lac is said to lose its solubility more rapidly than shellac and on this count alone would be less popular with the consumer. Both the United States Shellac Importers' Association of New York and the London Shellac Trade Association have definitely stated their views that lac arrives in a cleaner and generally more convenient form as shellac than as grain-lac.

On the question of admixture of rosin, the opinions of foreign consumers are divided. The New York market works on a clean basis free from rosin, whereas London works on a basis which allows 3 per cent. of foreign matter. The admixture of rosin in the manufacture of shellac with a view to lowering the melting-point has been a recognized practice for many years past. For some purposes, *e.g.*, the hat trade, the presence of rosin is generally preferred. Where rosin is used in manufacture, the proportion is generally 10 to 12 per cent. and this proportion is reduced by the dealer or broker to 3 per cent. by blending with pure shellac. Pure shellac is just as freely available as shellac manufactured with rosin, and the view that rosin is invariably used, in smaller or greater proportions, is wholly incorrect.

The same remarks apply generally to the use of orpiment, which is frequently employed in the manufacture of shellac in order to improve the colour. Dark colour in shellac usually indicates that the dye has not been completely washed out, and gives rise to the suspicion that other impurities also, such as dust, are present. This suspicion is not always well-founded. It is hoped that the prejudice in favour of light colour shellac, encouraging as it does the admixture

of orpiment, which really serves no useful purpose to the ultimate consumer, will diminish in course of time.

Adulteration.

The whole question of the adulteration of shellac, as of other Indian products, is one of great importance deserving special study. As already observed, the vast bulk of Indian shellac is produced by petty manufacturers, who are too often tempted by high prices to secure additional weight by adulteration. The commonest form of adulteration consists in the deliberate admixture of sand, ashes or even sugar with the grain-lac packed into the melting bag. The bag itself is purposely prepared of coarse drill, with the result that more or less fine particles of the adulterant pass through the bag with the molten lac, and add to the weight of the finished article. The degree of adulteration naturally increases when the demand for shellac is keen and prices are high. When prices fall and the purchaser can show greater discrimination, the practice is discouraged.

Adulteration will undoubtedly decrease as education extends and the trade becomes better organized. Possibly also there is room for improvement in the commercial tests at present applied. The commercial analyses most commonly employed are Parry's in London and Langmuir's in New York, but both methods attach more importance to the rosin admixture than to the quantity and quality of other foreign substances. Under the old form of Calcutta contract the penalty clause provided for an allowance of eight annas per maund for each percentage of rosin admixture up to four per cent., and one rupee per maund for each percentage over four. But practically no notice was taken of other foreign substances. Under the new form of contract, the allowance is one rupee per maund for each percentage of rosin up to four per cent., and two rupees for each percentage over four. With regard to other foreign substances, three per cent. are allowed free. The penalty is eight annas per maund for each percentage over three to five and one rupee per maund for each percentage above five.

Uses.

The treatment of shellac naturally varies with its quality and the use to which it is to be put. For varnish manufacture, it is reduced to a liquid by the use either of alcohol or of an alkali. In some cases, as in the manufacture of gramophone records, it is simply ground to a powder,

mixed with other materials and heated before use. White shellac is obtained by bleaching.

Twenty years ago, the principal uses of shellac were for varnishes and polishes, gums and cements; for sealing-wax and lithographic inks, and last, but not least, as stiffening material in the manufacture of hats It has also been applied as an insulating substance in the manufacture of electrical machinery and as a binding material in the manufacture of gramophone records These two last mentioned uses have since considerably expanded, and, in addition, a host of other uses have developed. A London expert has described the principal modern uses of the different varieties of lac in that market as follows :—

"High grade lacs are used for fine varnishes, for aeroplanes, pianos, furniture, shells (ammunition), sealing-wax, hats (silk, felt and straw), boot finish manufactures, gramophone records, and emery wheels.

"Low grade lacs for cheaper varnishes, for furniture, hats, sealing-wax, and for making bleached lac, for munitions (cartridges and shells) and for insulating purposes.

"Button lac is used for sealing-wax, hats, brushes, polishes, etc.

"Garnet is used for polishes, stains, hats (felt), sealing-wax, and emery wheels

"Grain-lac is used for lacquering metals and cables."

In America shellac is required for even wider purposes of which the following may be given as typical :—

"Abrasives and emery wheels, varnishes and polishes of all descriptions, billiard balls, moulding and picture frames, saws, glazed paper, photographic supplies, musical and optical instruments, watches, leather, oil-less bees-wax, guns, oil-cloth, paper board, lead pencils, paint and glass, tiles, automobiles, sealing-wax, hats, rubber tires, chemicals and drugs, phonograph records, pianola rolls, composition materials, electrical apparatus of all sorts, brushes and brooms, horse shoes, buttons, lacquer, foundry supplies, bottle tops, fly papers, hardware, toys, sports goods, typewriters, cements and glues, cutlery, mirrors, jewellery, confectionery, engravers' supplies, mint supplies and fireworks"

An expert has estimated that 40 to 50 per cent. of the entire demand is on account of gramophone records and that no other single industry can account for more than 5 to 8 per cent. of the consumption.

Substitutes.

The demand is thus steadily increasing. Not only is shellac driving out inferior materials hitherto considered as suitable, but it is also established as a vital necessity to expanding industries. The chief danger lies in the present high prices which merely encourage the search for a substitute. Hitherto the search has not been to any serious extent successful. During the war, when supplies of shellac for commercial purposes were restricted, the Merchants' Association of New York was asked by the War Trade Board to what extent the commercial consumption of shellac could be restricted and what substitutes were available. The reply was that, unless sufficient quantities of shellac could be brought to America to supply the normal demands of manufacturers, many industries would have to close down. The experience of Germany has been much the same. Synthetic substitutes had been evolved before the war, and were improved during the war, but still remain inferior to the natural product. So far as present prices in Germany go, the natural product is very much more expensive. It can only be purchased from Holland at prices ranging from 120 to 150 and even 200 marks per kilogramme, whereas synthethic substitutes can be secured at from 24 to 32 marks wholesale or 36 to 40 marks retail. The substitute can, however, only be obtained in very limited quantities, as the necessary raw materials, and particularly coal, are lacking. Moreover, it is reported in evidence of the indifferent quality of the substitute that German firms "are unable to deliver electrical machinery to tropical countries because the consistency of the insulating material made of artificial shellac and of mica powder is so poor that it melts in the heat."

It would be unsafe, however, to infer that the danger of the evolution of a successful substitute for shellac is not very real. The surest safeguard is to develop and extend production until supplies more nearly equal the demand, and prices fall in consequence to a more reasonable level. The departmental cultivation of lac by the Forest Department and the organization of supplies of brood-lac should help to secure this result; and it is hoped that the efforts of the Lac Traders' Association, now in process of formation in Calcutta, will be directed to the same end.

CHAPTER XII.

SUMMARY OF RECOMMENDATIONS.

The principal defects from which the lac industry at present suffers are, firstly, speculation and secondly, adulteration. Both have their origin in the peculiar conditions of the industry, the ignorance and improvidence of the cultivator; the long distances from which stick-lac has to be brought to the markets; the large number of agents through whose hands it passes; and the difficulty of estimating forthcoming supplies The following general remedies have been suggested in the preceding chapters.

In the first place, production should be stimulated in order that supplies may more nearly equal the foreign demand, which shows every tendency to increase. A detailed scheme is outlined in Chapter V for improved methods of cultivation on intensive lines, which might be adopted in Government Forests suitable for lac cultivation. In fact departmental working should, wherever possible, take the place of the present contract system which practical experience has shown to be unsatisfactory. In the second place, where any choice is possible in the selection of host-trees, preference should be given to those which produce the better qualities of lac. Thirdly, the greatest importance is attached to the organization of brood and demonstration farms in order that zamindars and cultivators may be assured of constant supplies of brood-lac of good quality, and may learn scientific methods of cultivation and collection.

It is suggested that action on the above lines should be undertaken where possible by provincial Forest Departments. The results should be not merely beneficial to private cultivators, but should also with careful organization bring in no small accession of revenue The two Governments chiefly concerned are those of Bihar and Orissa and the Central Provinces. Other Local Governments and many States will doubtless find it to their advantage to adopt similar methods. The two Governments mentioned would also be advised to appoint specialists to supervise the organization of lac farms and to undertake research in scientific methods of cultivation and collection.

Further measures suggested for Government enterprise are the publication of periodical reports on crop conditions in areas for which reliable information is forthcoming; and also the organization of co-operative credit societies for the maintenance and distribution of adequate supplies of brood-lac and for co-operative action in the extension of cultivation.

On the scientific side the late Mr. F. M. Howlett has suggested in Appendix III lines of research bearing chiefly on the life histories of the insect and its enemies and on the chemistry of lac. These investigations are, however, beyond the scope of provincial Forest Departments, and it is suggested that they should be undertaken by the trade itself. For this purpose funds may be made available by the imposition of a small cess on exports, and the funds administered by the Lac Traders' Association now in course of formation in Calcutta, on much the same lines as the Indian Tea Cess is administered by the Indian Tea Association. Expenditure on research may be roughly estimated at one lakh of rupees per annum. As exports during recent years have averaged 200,000 chests yearly, a cess of only eight annas per chest would give the required sum and would provide for expansion as trade increased. Later, as funds permitted, the Association might undertake the preparation of quantitative crop forecasts and also possibly propaganda work in foreign countries.

We endorse the suggestions offered by Mr. Howlett in Appendix III. We would, however, emphasize the importance of the Forest and Scientific lines of research being carried on at a single centre. We understand that Jubbulpore is likely to be selected as the site for forest research, and in this case we would prefer that the laboratory should be located at Jubbulpore rather than at Ranchi.

APPENDIX I.

TECHNICAL TERMS USED IN THE LAC AND SHELLAC INDUSTRY

A.—English.

Brood-lac ..	... Lac about to swarm and used for infecting host-trees.
Button-lac ...	... Refined lac made up in button shape.
Fine ...	.. Term used for the better grades of shellac.
Garnet-lac ...	... An inferior class of refined lac so called from its dark colour ; made up in thick slabs or shapeless lumps.
Grain-lac ..	... Lac crushed fairly uniformly to about the size of a pea and washed free from dye.
Lac-dye ...	... The colouring matter obtained from lac by washing with water.
Orange ...	... A grade of shellac so called from its light colour.
Seed-lac ...	... An ambiguous term synonymous with both grain-lac and brood-lac. Owing to this ambiguity it has not been used in this report.
Shellac ...	.. Refined lac stretched into thin sheets and then broken into small fragments The term is also used generically to include all forms of refined lac.
Standard I . .	... A grade of shellac just superior to TN.
Stick-lac ...	... Crude lac in all its forms.
Superfine ..	... The highest grades of shellac
TN ...	... Usually surrounded by a diamond, a non-proprietary mark of low-grade shellac.

B.—Vernacular

Antia .	. A bundle of brood-lac (Sonthal Parganas).
Arhatiya, Ardar.	... A commission agent or broker who conducts stick-lac sales.

Ari ...	... Lac collected before the insect has swarmed ; it contains the insect remains and therefore the whole of the dye.
Athali ...	... See Nand.
Baipari, Paikar	.. A wandering trader who buys lac from the cultivators
Baisakhi ...	... The summer stick-lac crop, excluding that from the Kusum tree.
Bakhari ...	... Stick-lac free from twigs.
Batri ...	... Synonymous with Baisakhi (Raipur).
Bhasmi ...	... Synonymous with Katki (Chattisgarh).
Bhatta ...	... The stove used for refining lac.
Bhilwaya ...	... The workman who stretches the refined sheets of lac.
Bichan ...	... Brood-lac.
Bihan ...	... Brood-lac (Orissa).
Bij ...	... Brood-lac.
Binda ...	... A bundle of brood-lac (Sonthal Parganas).
Biuli ...	... Stick-lac free from twigs and dirt.
Chalna ...	... A factory term for the process of sifting lac through a sieve.
Chaolapoka ...	... The larva of *Eublemma amabilis* (lit. "a grain of rice").
Chaori ...	... Grain-lac.
Chapra	... Shellac.
Charki ...	... Windlass for twisting the shellac bags.
Charna ..	... The basting implement used by the Karigar.
Chatki ...	... A stone mill for grinding lac.
Chaulia, Chawali	.. Lac on the stick (Orissa)
Chilwan ..	... Lac removed from the stick by scraping.
Chuchia ..	... The Hindi synonym for the Urdu "phunki."
Dalal ...	... A broker.
Dal-lac, Dali	.. Broken stick-lac about the size of large peas.

Danri ...	... The stiff rod into which the shellac bag hardens after it has been twisted up in the melting process
Dhanna ...	... A wooden block used in melting lac to guide the bag to fire.
Dom ...	.. Shellac inferior to TN.
Dongi ...	... The flat, smooth stone in front of the stove in a shellac factory.
Ekraya ...	.. Fine unwashed grain-lac.
Gada phunki	... Phunki lac from which the insect emerged in the godown (Raipur).
Garuhan ...	... Late phunki Katki (Raipur)
Ghasandar ...	... Literally "one who rubs"—The workman who washes grain-lac.
Ghonghi ...	.. See Pank (Imamganj).
Gulla ...	... A factory term for lac still adhering to the stick.
Halorna ...	... A factory term for the process of hand-picking lac.
Hartal ...	... Orpiment ; yellow sulphide of Arsenic.
Imamganj ...	... A manufacturing centre in Gaya district. The word is used for a poor grade of TN shellac.
Jethwi ...	... The summer crop of Kusum lac.
Juri ...	... Brood-lac tied up in a tree.
Kachha Chaori	... Unwashed grain-lac.
Karchhula ...	.. Shovel used by the Karigar for trimming his fire.
Karigar ...	... The shellac maker.
Karola, Kuni	... Small-sized grain-lac.
Karuan ...	... Early Katki or ari Katki (Raipur).
Katki ...	... The winter stick-lac crop from trees other than Kusum.
Katula ...	... Stick-lac full of twigs (Chota Nagpur).
Katwan ...	... Stick-lac removed from the twigs by pounding.
Ketka ..	... Kusmi lac, winter crop (Manbhum).
Khadi ...	... Biuli lac.

Khadi ...	... Brood-lac (Sambalpur).
Khari ...	... The twigs in stick-lac (c.f. Bakhari).
Khathi, Khathia	... Biuli lac (Orissa).
Kiri, Phog ..	. Refuse remaining in the bag after lac has been melted out.
Kirkhodni ...	... The gouge used by the Karigar to slit shellac bags for the removal of kiri.
Kula ...	... A tray used for winnowing grain-lac.
Kuni ..	... See Karola.
Kusmi, Nagoli	... The winter stick-lac crop from the Kusum tree.
Lactora, Lahi	... A lac cultivator.
Lakh .	... Lac.
Lakhwa ...	... A lac cultivator.
Lakhera ..	... A lac-growing plot.
Loka ...	... Lac on the stick (Raipur).
Lora ...	... Brood-lac (Raipur).
Magasur ...	... Kusmi lac (Raipur).
Minjana ...	... A single washing in the process of cleaning grain-lac.
Molamma ...	... The fine lac, mixed with dust, obtained by winnowing grain-lac.
Nagli, Nagoli	... See Kusmi.
Nand, Athali	... A stone jar about $2\frac{1}{2}' \times 2\frac{1}{2}'$ with the inside serrated, used for washing grain-lac.
Nera . .	... A palm-leaf frond used for spreading molten shellac on the Pipa.
Paikar ...	... See Baipari.
Palasi ...	... Lac from the Palas tree.
Pank or Phak	... Scum collected from the first washing of grain-lac.
Panna ...	... A single sheet of stretched shellac.
Parsi ...	... Lac from the Palas tree.
Passewa ...	... Lac washed out of the melting bags by boiling with water and Fuller's earth.
Pathri ...	... A depression in the Dongi containing water.

Pera ..	... The portion of the melting bag in front of the fire.
Phal ...	.. A factory term for lac cleaned of twigs.
Phirwaya ...	... The coolie who turns the windlass to rotate the melting bag.
Phog ...	... See Kiri.
Phunki, Phungi	. Stick-lac collected after the insect has swarmed from it.
Phuswa . .	... Phunki (Raipur).
Pipa .	.. The porcelain cylinder containing hot water on which the Karigar places the molten lac for the Bhilwaya
Pirbanda ...	... Instrument used by the Karigar for removing molten shellac from the bag.
Rangbatti ..	. . Lac-dye.
Rangeen ...	... Katki, or winter crop from trees other than Kusum.
Reh, Sajjimatti	... Fuller's earth.
Safa chaori	... Clean washed grain-lac
Sagar ...	... Mixed stick-lac of all kinds (Nimar)
Sajjimatti ...	... See Reh.
Sona phunki	... Phunki lac from which the insect emerged in the forest.
Sup ...	... Tray for winnowing lac.
Tarashi .	... Pruning.
Thaili ..	... Sausage-shaped bag in which lac is melted.

APPENDIX II.

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APPENDIX III.

SUGGESTIONS FOR RESEARCH.

I have been asked by the writers of the Report to suggest a general "Scheme of Research" which might constitute a suitable programme for the work of a Lac Laboratory. It should be understood that the enquiries outlined below are merely the suggestions of a biologist who has devoted some attention to the study of insects, and indeed, it is never possible for any one man, however gifted or presumptuous, to foresee the lines along which other men with original ideas may best advance our scientific knowledge of a subject, or to lay down the law as to the precise manner in which they should attack its problems.

Many people forget, or do not know, that what is officially known in this country as "Research" should really be considered as two practically distinct types of enquiry. One type of "researcher" must be born, while the other may be made. The first is the man with an original mind seeking new discoveries, he looks for unknown relations between things, invents ways of explaining known relations in some new way, or devises some fresh method of technique which shall reveal unsuspected facts and relations. Originality of method, thought, or outlook is the characteristic of his work. Work of the second type, on the other hand, does not require and is not characterized by originality, though it may demand technical skill and accuracy of observation. It consists mainly in description, in the collection of data, and the application of familiar laws and methods to particular cases.

Of these two types the first may be the more valuable, but the second is the more common, and is the only one that is amenable to direction and control. Only one man can direct or control *original* research, and he is the researcher himself; so that in "schemes of research" to be carried out under direction, we can hardly legislate for him, since he will work according to his own ideas and not according to ours, and in making a scheme, all that can be done (and all that is here attempted) is to select certain points where enquiry seems most likely to lead to practically useful results, and where it

will at the same time contribute to the building up of a coherent body of reasoned knowledge regarding the whole subject.

Lac is at present a valuable monopoly in India, with a demand that will probably increase, but it would be short-sighted to assume that the present favourable conditions must continue indefinitely, or that India's great natural advantages in the matter of lac production must necessarily safeguard her against all competition. In an industry of this sort there are two obvious directions from which competition may have to be faced. Either (as in the case of indigo) a substitute may be discovered sufficiently good and cheap to supplant the natural product, or (as in the case of silk) other countries may succeed in establishing the lac insect and may undersell India by the application of scientific knowledge and organization to their methods of production.

The position of the industry will be much strengthened if the possibility of future competition is recognized, and if arrangements are now made for carrying out such work as may be necessary for attaining increased efficiency in production and general economic stability.

Of the two stabilizing methods recommended in this Report, the Forest Department is carrying out the first, by the expansion of the area of departmental lac cultivation in Government forests, an area which has hitherto been practically negligible as compared with the total area of cultivation. In connection with this expansion it is proposed to create a certain number of "brood-farms" for the production of brood-lac and its sale at a reasonably low rate to local cultivators.

With respect to the second method (the establishment of some form of research organization) it is suggested that the trade might engage the necessary scientific officers and finance the work of a lac laboratory for a suitable period. These officers would work in close touch with the Forest Department, but in the interest of the trade.

Preliminary grouping of enquiries.—The processes to be investigated are those that convert the carbon dioxide of the air and the plant-sap rising from the ground into any one of the many forms in which shellac reaches the public. To be in a position effectively to control this chain of processes in the interests of the industry (which,

is our ultimate aim) we want, in a general way, to know three things.

Firstly, the precise nature of each process in itself, secondly, the way in which it depends on or is related to the processes that precede or follow it, and thirdly, how each process is or can be modified to our desire by altering the circumstances under which it takes place Further, as a means of enhancing nett outturn, it may be necessary to enquire into causes of loss at various points in the chain, and the means of checking it.

In carrying out this chain of processes three chief agents are involved · plants, lac insects, and men

(1) *Plants* extract from the soil and air certain substances that are then worked up into the more elaborate forms of "protoplasm," cellulose, starch, sugar, oil, tannins, etc., etc.

(2) *Lac insects* suck up some of these products from plant and from them manufacture lac.

(3) *Men* collect the lac, remove dirt and dye, and convert the resin and wax into shellac. The shellac may undergo some slight further manipulation to fit it for special purposes.

Men also assist the lac insect by "lac cultivation" to find suitable and sufficient food in successive generations.

It will be obvious that the central and crucial process is number (2), and one group of enquiries will be those concerned with the insect, with the way inwhich it makes its lac and the nature of the raw materials it uses, with methods of increasing its output and checking loss from enemies or other causes. A second group will be those enquiries concerned with the plants that supply the insect with its food and raw materials particularly with regard to the conditions most favourable to their growth, the best practical methods of growing them for lac production, and the means of obtaining from them the greatest yield of raw material without undue detriment to their vitality.

On the results of these two sections of enquiry almost all improvements in general methods of lac cultivation in the field will depend. We have, therefore, no good reason for any separate group of enquiries under the head of "cultivation" but we have still to deal with the highly important processes of "manufacture" which are certainly

deserving of special enquiry. These processes, however, have already been made the object of investigation by various firms and individuals; a number of patents for particular methods or apparatus have been issued, and work in various directions is still in progress.

It is probably advisable to leave this section of enquiry to those who are already engaged in it, and who have spent no small amount of time and money in its pursuit. With a closer linking up of interests it might at some future time be possible to suggest for the common good a somewhat closer co-ordination of these scattered efforts, but for the present it seems best to concentrate attention on the biological and physiological study of the sources of supply, the insect and its food-plant, rather than on the chemistry and technology of manufacture.

If then we assume that research may for the time being be practically restricted to the insect and the plant, and that it is to be carried out partly in a laboratory run by a Lac Association and partly by officers of the Forest Department working in concert with the Association, the general arrangement of work might be very simple. The Lac Laboratory would undertake all work on the insect, the physiology of lac production, and the insect's enemies and parasites. The work undertaken by Forest Officers (excluding that of a more immediately practical nature) would include the general study of the "host" plants, but would deal especially with the most economical methods of utilizing a given plant as a continued source of raw material for lac production.

Though not closely connected with "research", the question of a crop forecast may here be touched on, as it is one of considerable importance. The establishment of reliable machinery for such a forecast would presumably be correlated with the gradual expansion of forest cultivation and with the increase in the number of "brood-farms", whose periodical reports would probably afford the safest basis for computing the average condition of the crop in their particular areas, if an arrangement could be come to whereby such reports could be furnished for the information of the Association.

If we may assume effective collaboration between the Forest Department and the Association, a definite division of labour between them in the matter of research will not only economize time and effort, but will also avoid competition or controversy. Both

competition and controversy are excellent things in their way, but in the early stages of tackling a complex subject they are too apt to mean waste of energy on unsound work and "eye-wash". In what follows I have taken it for granted that effective collaboration exists and that a reasonable division of labour is therefore practicable.

Staff and Equipment.—A staff might be engaged in the first instance for a period of five years. Appended is a list of the posts recommended, and a rough estimate of initial and recurrent expenditure involved in the maintenance of a Lac Laboratory on a suitable scale. If the success of the work justified it, some enlargement might be considered advisable at a later date.

Staff and Salaries	Initial	Annual Recurrent
	Rs	Rs
1 Laboratory Director on	1,500—2,000	21,000 (average)
1 Entomologist	500—750	7,500
1 Chemist	500—750	7,500
1 Physiological Assistant	400—600	6,000
1 Entomological ,,	300—500	4,800
1 Chemical ,,	250—300	3,300
1 Botanical ,,	250—300	3,300
1 Superintendent	150—200	2,400
1 Artist-Photographer	150—200	2,100
1 Head Fieldman	150—200	2,100
1 Fieldman	100—150	1,500
1 ,,	75—100	1,050
1 Laboratory Keeper	50—75	750
1 Stenographer	150—200	2,100
1 Clerk and Recorder	100—150	1,500
1 Typist	75—100	1,050
Menials and subordinates	150	1,800
		69,750
Buildings		
Laboratories, Offices, Stores, Museum, and Insectary	24,000	
Furniture, almirahs, racks and shelving, boxes and insectary fittings, museum fittings	6,500	1,000
	30,500	1,000

Staff and Salaries	Initial		Annual Recurrent
	Rs		Rs
MATERIALS AND APPARATUS			
Microscopes and lenses	3,000		300 (average)
Chemical and Physical	4,000		1,500
Glass and biological apparatus, reagents, stains, spirit, and microtome outfit	3,500		1,500
Photographic and micro-photographic outfit, projection apparatus, and artist's material	1,750		500
Tools, insectary apparatus, fees to specialists, and miscellaneous laboratory expenses	750		500
	13,000		4,300
Printing and minor publications	250		500
Books, Postage, Stationery, Repairs, and Sundries ...	2,000		1,000
Motor car, chauffeur, and upkeep	4,000		1,750
Travelling allowance of Staff			6,000
Total Initial Expenditure	49,750	...	...
,, Recurrent ,,			84,300

It will be seen that the cost of site, necessary roads or paths, and of water, gas, or electric supply have all been omitted, as they vary so much with local conditions. For the same reason no estimate has been made of the cost of house-rent allowance or quarters.

Location of Laboratory.—The cost of the laboratory building has been kept at a low figure, because an impressive exterior is less important than equipment and location. I consider that the most important points in deciding its position are (1) that it should be in a lac-growing area, though not necessarily in a forest, (2) that it should be if possible in a climate sufficiently temperate to permit of critical laboratory operations (such as section-cutting) being performed without inconvenience all the year round; (3) that it should be within reasonably easy reach of the headquarters of the industry in Calcutta.

The writers of the report suggest Jubbulpore as a suitable locality, and at present this is certainly the best centre for the study of the departmental development of cultivation in Government

forests. As a centre for research, however, Ranchi is probably superior, and I therefore suggest it as one of the very few localities that meet the three above-mentioned requirements. Forest Officers concerned with lac development should of course be given every facility for visiting it.

Nature of Work.—An outline of what might be the main enquiries carried on is herewith appended.

A.—Work on Food-plants.

1. Distribution of the main food-plants and the optimum conditions for their growth, especially with reference to climate, altitude, and soil.

2. Comparison of the amount and quality of lac got by equal inoculation of different species of plant with insects of the same brood.

3. Comparative resistance of different species of plants to heavy inoculation, decrease in yield and period necessary for recovery (With this is connected the practical working of rotation systems such as that suggested in Chapter V of the Report.)

4 Possibility of more concentrated or intensive cultivation of food-plants, with special reference to the introduction of crop cultivation as in the case of arhar in Assam ; or bush cultivation as with mulberry for silk-worms

5 Effect of transference of insects from one species of plant to another, regarding yield and quality of lac and vitality of insect

6 Relation between periods of greatest metabolic activity of the plant and of lac production by the insect Means of artificially stimulating the plant's production of food-stuffs or raw material used by the insect.

Most of this section of the enquiry would be suitably carried out by Forest Officers, and little or no laboratory work is involved

B—Work on Parasites.

1 The identity of the various parasites and enemies of the lac insect. Their geographical distribution, seasonal prevalence and relative importance.

2. The general life-history of each parasite and its relations with the life of the lac insect The relative amount of loss sustained

in different areas from the attacks of parasites. Correlation of parasite abundance with climatic or any other conditions.

3. Determining whether or not the various parasites have "alternative hosts" other than the lac insect. Dr. Imms' scheme is as follows: that an isolated area should be planted with lac, only one crop (Katki) being taken in the year; brood-lac for inoculation would be brought in each year for say three years from some locality relatively free of parasites. The amount of parasitic attack would be carefully watched; if it remains slight throughout, the lac insect is probably the only host of the parasites concerned; if it increases, the lac is probably being infected by parasites reared on other hosts in the neighbourhood.

4. If alternative hosts are present, the possibility of destroying the parasites through destruction of the alternative host at certain seasons.

5. Period of late emergence of parasites and utility of measures such as fumigation.

6. Determination of the relative severity of parasitic attack on lac of different varieties or from different food-plants.

7. Determination of the means whereby the parasites discover the lac insect at the particular stage in its career when they are accustomed to infect it. If by the smell of the lac, can the odoriferous substance be isolated and used as bait to destroy them? Are repellent sprays practicable?

8. The discovery of "hyper-parasites" and other enemies of the parasites; the possibility of using them as means of defence.

9. Using all facts obtained to help in devising methods of evading, repelling, trapping, disabling, or destroying parasites.

C.—WORK ON THE LAC INSECT.

(a) Entomological.

1. Study of the external structure of insects from different localities and food-plants, to ascertain the existence or otherwise of definite morphological species or varieties.

2. Study of the life-history of the insect, with special reference to the period of emergence in different localities, and the influence thereon of temperature, humidity, altitude, and food-plant.

3. Definition of the limiting and optimum conditions for the insect, especially temperature, moisture, and altitude; the relation between this optimum and that for different food-plants.

(b) Genetics.

4. The course of development of eggs and young; variations in fertility, and influence on fertility of different food-plants and climatic or other conditions.

5. Selective breeding, and the extent to which yield and quality may be improved by the distribution of pedigree stock.

6. The possibility of three-brooded varieties and the extension of their cultivation (with special reference to the introduction of crop cultivation, for which a three-brooded variety would be very suitable).

7. If the existence of a three-brooded variety is confirmed, or other definite varieties exist, the possibility of hybridizing or crossing varieties on Mendelian lines for the creation of new forms of greater productivity, fertility, or hardiness.

(c) General Physiological.

8. In connection with hybridizing, the invention of methods for rearing insects individually under observation.

9. Invention of any methods for rearing insects on a more intensive and concentrated scale as is done, for instance, with silk-worms.

10. Study of the reactions leading to swarming and to fixation (*i.e.*, variations in "heliotropism," "chemotropism," etc., in the insect's early stages).

11. Definition of the qualities or characteristics which determine the insect's preference for particular food-plants or which render a plant suitable for its food; determination of the qualities or characteristics which render it unsuitable.

(d) Physiology of Lac Production.

12. The structure of the lac-secreting glands

13 The course of development of the glands in the life of both sexes.

14. The products secreted by the different glands, and the variation in these products (if any) with the age of the insect.

15. The variation in these products with the food-plant.

16. Micro-chemical methods of distinguishing these products (*e.g.*, by intra-vitam or *post-mortem* staining, etc.).

17. Variation in the amount of particular products caused by special treatment of the food-plant, as by watering, manuring, or injection with chemical substances.

18 Variation in products caused by alterations in temperature, humidity, or other physical conditions.

19. Correlation of the results obtained under foregoing headings and formation of working hypotheses regarding the process of formation of lac.

20. Experimental testing of hypotheses; practical application as a means of increasing production and controlling quality.

D. CHEMICAL AND MISCELLANEOUS.

1. Analysis of substances present in good food-plants and comparison with those in bad ones, with respect to those likely to serve as food or raw material for lac insects.

2. Analysis of lac from different food-plants and at different stages in the insect's life.

3. The same with special reference to the amount of wax and dye.

4. Removal or recovery of wax from special varieties of lac or kiri.

5. Testing and comparison of physical properties of lac from different food-plants, and the relation of these results to those got by analysis.

6. Preparation of artificial food-stuffs for the insect, in connection with headings C 8 and 9.

7. The general utilization of results in devising improvements in cultivation and securing better quality or increased yield with more security, less trouble, or less expenditure.

The collection, filing and indexing of all obtainable information, which should be available for the use of accredited enquirers.

Correspondence with Forest Officers, specialists, and others.

The submission to the Association of such reports as might be agreed upon, and the publication of results subject to the Association's veto.

APPENDIX IV.

LOCAL NOTES.

Sonthal Parganas.

This district, together with the adjoining areas in the Murshidabad and Malda districts of Bengal, presents somewhat of an anomaly as a lac-growing area, on account of its low altitude, most of it being below 600 ft. The reason why lac is found at this level is not definitely known. All that can be said is that the favouring rains of the cold weather are usually well distributed in the Sonthal Parganas, while the dry west winds of the open season, which are always adverse to lac cultivation, are not prevalent.

Lac is found in two fairly definite areas, the Dumka area and the Pakaur area. The former is nearly all Palas, and lies west of and just including Dumka. The Palas tree is quite common throughout the area, and usually occurs on open cultivated land. Dumka is the central bazaar and there are subsidiary bazaars in Haripur, Kumrabad, Jarmundi, Nunihat, Kangatta, Lakkapalasi, Barahat and Dumaria. It is said that this area used to produce annually some 10,000 maunds of lac, but hardly 1,000 maunds have been produced in recent years. The cause of the decrease is said to be the famine of 1916.

The principal dealers in Dumka are :—

Girdari Lal Marwari.
Ganpat Marwari.
Mahadeo Lal Marwari.
Jai Narayan Sahu.
Silochan Sahu.
Rameshwar Marwari.

There are two factories in Dumka, four in Nunihat, two in Jarmundi and two in Haripur, although small and unimportant, they are capable of refining between them the whole of the lac now produced in the Dumka area.

Pakaur is the centre of a very large lac area on the other side of the district and also taps very important areas in the adjoining districts of Murshidabad and Malda In the Sonthal Parganas most of

the Pakaur lac is grown in the Pakaur sub-division but extends also into the Rajmahal and Dumka sub-divisions. The principal—almost the only—tree on which it is grown is Ber, and local trade recognizes three qualities according to soil:—

1st quality Pahari lac grown on the hills.
2nd quality Bagri lac grown on black cotton soil.
3rd quality Rahi lac grown on Laterite.

These varieties are purely local and the differences are slight. An interesting local report is that Pahari lac is not allowed to reproduce itself but is always grown from Bagri brood; this requires confirmation. Lac is generally cultivated in homestead lands, on trees apparently planted originally for the sake of their fruit. The system is to retain one tree in ten for brood and to collect the balance as *ari* lac. The land is all under zamindari settlement and for the purposes of the Tenancy Act in the Sonthal Parganas lac has been defined as a fruit, so that tenants are entitled to its free use within their holdings. For other trees zamindars collect revenue by trees (2 or 4 annas per tree) or by area, but custom varies greatly. In the settlement of 1912, the rights of zamindars to collect this revenue were registered, and many trees were cut down by the tenants in an attempt to destroy landlords' rights over them. Ber coppices well, however, so that there has been no permanent loss.

Cultivation by tenants is often financed by the local merchants (mahajans) and the raiyats are frequently heavily indebted on this account, particularly the Paharias, who always grow their lac from imported brood.

Pakaur is the principal market and in a good year about 75,000 maunds of Baisakhi and 20,000 maunds of Katki pass through, but probably three-quarters of this amount is brought in from outside the district, mainly from Murshidabad and Malda, but also from Purnea and other districts north of the Ganges. A small quantity is also brought in from Nepal State (from near Biratnagar). Subsidiary markets are Hiranpur, Litipara, Amrapara, Kotalpakaur in the Sonthal Parganas and Jangipur, Dhulian, and Berhampur in Bengal.

The principal dealers and buyers in Pakaur are:—

Hiralal Jabulal.
Thakur Pd. Kalicharan.

Kanhai Lal Onkar Nath.
Rameshar Prasad
Munshi Md. Ali

These men are also mostly manufacturers or interested in factories, of which there are three large (30—40 stoves each) and eight smaller. There are also five small factories and one large one in Kotalpakaur. A large quantity of stick-lac is exported to factories in Calcutta and elsewhere.

The hilly portion of the centre of the Sonthal Parganas forms a large Government Estate—the Damin-i-koh (the "edge of the hills") —and in this there is opportunity for Government action in the supply of brood-lac and in demonstrating to neighbouring zamindars up-to-date methods of propagation, pruning and collection. Lac is already grown in this area largely by Paharias, and the Forest Department collects a royalty of Re. 1-4-0 per maund of lac sold in the bazaars. The cultivators are generally heavily indebted to the mahajans who supply them with brood-lac and take two-thirds of the crop. Government has tackled the difficult problem of indebtedness by establishing throughout the Damin-i-koh grain *golas* from which seed is advanced to the tenants and recovered with reasonable interest at harvest time. With this machinery already in existence, much might be done to set the lac industry on an improved footing. The local Forest Department might be responsible for the production and distribution of brood-lac. against which recoveries of cleaned stick-lac would subsequently be effected. A start might be made at Hiranpur and Amrapara.

The Government Forests, and the whole of the Damin-i-koh, are said to contain numbers of Kusum trees, but it is very doubtful whether the numbers within a reasonable area are sufficient to make it worth while attempting to introduce the cultivation of lac on them They have not been cultivated up till now and success is doubtful owing to the unusual climate An experiment would, however, be interesting and would give useful data even if it did not actually succeed. At present the raiyat does not realize the value of Kusum as a lac producer, and many of these trees are cut for sale as timber and firewood.

The Dumka Palas area is wholly outside the Government Estate An area containing Palas trees near Dumka might be acquired and

managed by the Forest Department for demonstration purposes and for the supply of brood-lac

BIHAR.

Small quantities of lac are produced throughout most of the Bihar districts, but it is doubtful whether its cultivation is capable of much extension. Palas and Ber are found in parts of the area, but the climate appears to be far from favourable, particularly in the cold weather, and, though the production is undoubtedly capable of expansion, the possible total is not likely to be sufficient to warrant any special measure.

At present, a certain amount of lac is marketed annually at Chapra and some also arrives at Pakaur from Purnea and adjacent districts. In both cases the totals are, however, quite small.

GAYA.

The importance of Gaya district lies chiefly in the shellac manufacture carried on at Imamganj (including Raniganj), a village lying in the angle of country between Hazaribagh and Palamau districts. Lac is grown in this area, and along the southern border of the district. A small quantity is produced near Daudnagar on the Sone river, and in other parts of the district.

The methods of cultivation employed are similar to those in Chota Nagpur but are rather more primitive. Important cultivators are :—

Akhbar Hussain Khan of Kothi, P. S. Imamganj.

The Raja of Kunda (Hazaribagh), Proprietor of Raniganj.

Abdul Kadir Khan of Malhari, P. S. Imamganj.

Abdul Rahman Khan of Malhari, P S. Imamganj.

Chhatardhari Sahu of Bihopur.

Jagu Singh and Nagesar Singh of Jamuna.

Sharafat Khan of Kothi, P. S. Imamganj.

Imamganj is the only market of any importance. It appears to receive about 40,000 maunds of Baisakhi, 20,000 of Katki and small quantities only of Kusmi and Jethwi. Much of this lac, however, comes from adjoining areas in Palamau and Hazaribagh districts, and Gaya district itself produces 25,000 maunds annually.

There are twelve factories at Imamganj (including Raniganj) and one each at Sherghati and Mathurapur. The largest manufacturers are :—

Janki Lal Seth.
Ganga Ram Jai Narayan
Bishan Sahu Baldeo Ram.
Ajediya Sahu (Sherghati).
Bishan Sahu Sri Ram
Bhagwan Das.
Pragsau Govind Lal.
Behari Sahu, son of Deoram.
Ishardass, son of Ramnarain.

The total number of stoves is in the neighbourhood of 150, so that the annual possible outturn is about 30,000 maunds of shellac. The manufactured shellac is carted by road to Gaya and thence railed to Calcutta.

Imamganj is chiefly notorious for the poor quality of the shellac manufactured. In fact "Imamganj" is tending to become in Calcutta a definite name for a grade of shellac below TN. There is no reason at all for this, other than carelessness on the part of the manufacturers and the crudity of their methods. It is hoped that the revision of the Calcutta buying contract and the penalties imposed on adulteration will go a long way to rectify this state of affairs.

HAZARIBAGH.

Almost all the lac produced in this district comes from the area lying south-west of the Grand Chord Railway Line; and lac can be grown over most of this area, although at present the majority comes from the northern and western portions of the Chatra subdivision. Cultivation can be extended almost indefinitely, particularly in the neighbourhood of Ramgarh. The greater part of the lac is grown on the Palas tree, with Ber a bad second and Kusum a worse third. Kusum is quite a common tree and used to be more extensively infected than it is now. The cause is said to be the almost complete failure of the Kusum crop some years ago, and the consequent impossibility of obtaining Kusum brood. The local authorities are alive to this emergency and proposals are being framed to meet it.

There are no Government Forests in the lac area and as cultivation is mostly on Palas, it is usually met with, not in homestead but in waste lands. The zamindar is sometimes considered to own the right of cultivation, but in many cases tenants have succeeded in establishing a customary right. Where the zamindar's right is established, he usually grants small leases for cash or for a share of the produce. Cash leases are usually for long terms, nine years being a common period. Produce leases are of two kinds. If the lessee is a Kamia (*i.e*, practically a serf of the zamindar) the custom is for the landlord to provide the brood and finance the business. He takes all the crop except one-eighth which the Kamia receives as his share. On the other hand the better class of tenants are naturally able to hold out for better terms, and their lease is usually on a basis of three-fourths of the yield to the zamindar and one-fourth to the tenant, the brood being provided by the zamindar or cultivator according to their relative business acumen. Cash rents have become more popular of late years particularly with absentee landlords.

Lac is usually collected by Baiparis, but zamindars have realized the profit to be made on this side of the business and some of them, particularly where produce leases are common, take the whole of the lac and credit the cultivator with his share against his land rental or against advances of grain or other commodities.

The stick-lac finds its way eventually to Chatra market or to Imamganj (Gaya district), Ranchi or Jhalda (Manbhum); there are smaller markets at Hunterganj and Sherghati. With so much of the produce marketed outside the district it is impossible to say how much is grown within it. In a good year the Chatra market probably deals with 20,000 maunds Baisakhi and 10,000 maunds Katki. It is quite impossible to estimate the crops from Kusum, but they may easily be of considerable importance.

Some lac from this district also finds its way to Daltonganj, Lohardaga and Hazaribagh.

The largest cultivators of the district are :—

Irshad Ali Khan, of Bhadia (Gaya district)
Khirodhar Sahu of Chatra
Mither Nichaundhia of Amarut (Gaya)
Doman Nichaundhia of Chatra.

The largest dealers in Chatra are :—

Hari Baksh Seth, Marwari

Sowa Lal Seth

Bansi Lal Agarwala.

There are two small factories in Chatra belonging to :—

Hari Baksh Seth

Sowa Lal Seth,

but neither is large enough to be really important.

Hazaribagh district is most favourably situated for Government action to improve the lac industry, as the greater part of the lac-growing area is in the Ramgarh Court of Wards Estate. The selection, and if necessary the acquisition, of areas for brood farms and the introduction of machinery for the distribution of brood, etc., should not be difficult.

Palamau.

Palamau is one of the most important lac districts, being second only to Manbhum. Most of the lac grown is on the Palas tree, patches of which are a common feature all over the district. Very little lac is grown on Ber or Kusum, though the latter is a common tree in the more heavily wooded and hence more sparsely populated parts of the district. The reason why Kusum is not much cultivated is because it is a tree of the forest and not of the open country, and also because it is never gregarious. Its cultivation requires considerable care and attention, and hence is unpopular despite the fact that it yields a larger quantity and better quality of lac than Palas. Further, Palamau is a field for the recruitment of coolies for the tea districts. Labour is thus not so plentiful as it would otherwise be, and, what there is, is fully employed in agriculture. Hence there is practically no chance of lac cultivation being developed except in suitable areas within easy reach of existing villages.

The Palamau zamindars claim all rights over trees capable of producing lac, and this is frequently their chief source of income. They usually make a simple verbal settlement with their raiyats from whom they secure as high a rate as possible; four annas per tree is a common rate. In addition, many zamindars auction to Baiparis the rights of collection within their estates. Whether the zamindar helps the Baipari to enforce his monopoly or not, is a risk which the latter must face, and, on the whole, this method of sale is not usually

very remunerative. In Government Estates it was decided in 1916 that trees standing in cultivated areas should not in future be assessed for lac; trees growing in unoccupied lands are leased at from one-half to one anna per tree.

The principal markets in Palamau are Daltonganj and Garhwa. At these towns are marketed most of the lac from the Dudhi area (south of the Sone river) of Mirzapur district and also small quantities from Sirguja State and Hazaribagh district. On the other hand a small quantity of lac from Palamau goes direct to factories in Imamganj (Gaya).

The principal Arhatiyas in Daltonganj are:—

Mahabir Prasad
Bhui Ram of Shahpur
Kedarnath Surajmal
Nand Kishore Misria
Teka Pande

And in Garhwa:—

Nanku Ram
Ghasi Ram Baldeo Dass
Kedarnath Sahu (of Rehala).

With a good crop the yield would probably be:—

	Baisakhi.	Katki
Daltonganj	30,000	15,000
Garhwa	40,000	20,000

but a small and varying quantity of Kusmi and Jethwi, up to 300 and 1,500 maunds, respectively, is also sold.

The greater part of this lac goes to Mirzapur, and Palamau is the most important source of stick-lac supplies for Mirzapur. The larger manufacturers retain agents in the district and numbers of dealers visit Daltonganj and Garhwa as the crops come in. Proposals have been prepared by the Forest Department, and are under consideration by the Local Government, to acquire a suitable area under Palas near Daltonganj, for experiment and demonstration purposes and for the supply of brood-lac. There is scope for an experiment of this kind and it is hoped that its success will be such as to encourage

the development of similar demonstration areas in other parts of the province. The experiment would appear to have greatest chances of success if the areas thus taken up could be notified as Reserved Forest. The chief difficulties will arise from theft and also from the scarcity of labour, but these will doubtless be overcome by the provision of forest guards and other adequate staff, and by the selection of sites where labour is available. The existing Government Forests are extensive, but are remote from more populous areas, so that labour is scarce, and they would not be so suitable as centres either for demonstration work or for the supply of brood-lac.

Ranchi.

Lac is found over the whole of Ranchi district and is brought into small bazaars throughout the area. The district, which is situated on a plateau about 2,200 feet above sea-level, enjoys an equable climate and comparative immunity from severe frost. It is thus in every way suitable for lac cultivation, while at the same time there is plenty of scope for development. Kusum trees are common throughout the district, although at a rough estimate probably not more than five to ten per cent. of them are at present cultivated. Ber is also common and so is Palas, particularly around Muru on the Chaibassa road.

The principal markets are Ranchi, Bundu, Lohardaga, Khunti and Mananghatta, while a considerable part of the crop in the north-east of the district finds its way direct to Jhalda and Balarampur in Manbhum district.

Good crops under present conditions would be:—

	Maunds
Kusmi	20,000
Jethwi	10,000
Baisakhi	35,000
Katki	20,000

excluding that portion which goes direct to Jhalda These figures have not been reached within recent years. The possibilities of the district are great, however, and there is no doubt that, if conditions of price and weather are favourable, the above figures could be doubled without much difficulty.

The relations between zamindar and cultivator are the same as in Manbhum, and cultivation is practically always by small holders. Manufacture is not highly developed as yet, and most of the stick-lac is exported to Jhalda and Balarampur in Manbhum for manufacture.

There are, it is true, two large factories in Ranchi belonging to Rai Sahib Thakur Das and Rang Lal Sahu respectively. The former has about 45 working stoves; the latter about 70. Rai Sahib Thakur Das has also a branch factory at Muru. Besides these, there are only a few small factories in Bundu. As one would expect from a district producing quantities of Kusum lac, the grades manufactured are largely fines and superfines of private marks, both in the form of orange shellac and button-lac. The district presents an excellent opportunity for the extension of manufacture. Communications are fairly good and Ranchi and Lohardaga suggest themselves as suitable localities for factories.

Government assistance in the extension and improvement of cultivation is most desirable. The field is large, but unfortunately sufficient local knowledge has not been obtained to make it possible to suggest definite areas for brood farms, although the neighbourhoods of Bundu, Khunti and Lohardaga appear to be suitable.

MANBHUM.

Manbhum is the biggest and most important lac-producing district in India. Lac is grown throughout the district, but chiefly in the western and southern portions of the Sadr sub-division in thanas Chas (west), Jhalda, Baghmundi, Ichagarh, Chandil, Barabazar, Bandwan and Manbazar. The important centres of the lac-growing area are Balarampur (Barabhum), Jhalda, Chas, Manbazar.

A small quantity is also collected in the north of the Dhanbad sub-division with centre at Gobindpur.

The principal host-trees are *Schleichera trijuga* (Kusum), *Zizyphus Jujuba* (Kuli, Ber or wild plum), *Butea frondosa* (Paras or Palas), but lac is also grown in small quantities on *Dalbergia latifolia* (Satse), Ficus spp., *Ougeinia dalbergioides* (Pandon) and many other trees.

Cultivation is more intense in this district than anywhere else in India. The methods are, however, not much more advanced. The ease with which Ber can be grown and the quality of its lac crops have led to a certain amount of artificial regeneration of the species. The clumps of Ber round the village sites are a feature of this landscape and in some cases gardens (*baris*) have been given up entirely to its cultivation. Very occasionally regular plantations of Ber up to an acre in extent are to be seen. The trees on a tenant's holding

are generally considered his own and he pays nothing for the right to cultivate. Zamindars lease out the trees growing in forests and waste lands at a few annas per tree according to size and species.

The principal stick-lac markets and the crops of clean stick-lac in maunds to be expected in a good year are as follows:—

Market.	Kusmi	Jethwi	Baisakhi.	Katki
Balarampur . .	12,000	5,000	25,000	10,000
Jhalda . . .	25,000	8,000	45,000	16,000
Chas		...	10,000	5,000
Manbazar	..		20,000	6,000
Katras		..	2,000	1,000
Gobindpur	.	.	2,000	1,000

The Baisakhi and Katki crops in Balarampur and Manbazar are mostly from Ber; in Chas, Katras and Gobindpur most from Palas; and in Jhalda about equal quantities of Ber and Palas.

The bulk of this lac is manufactured into shellac within the district, though considerable quantities of stick-lac are exported to Calcutta and other manufacturing centres. A very large quantity of stick-lac is imported into Manbhum for manufacture into shellac chiefly at Balarampur and Jhalda. In a good year as much as 1,50,000 maunds of stick-lac are imported into Balarampur and 50,000 maunds into Jhalda. The bulk of this lac comes from Ranchi, Orissa and the Central Provinces. Large quantities are also imported by road into Jhalda from Hazaribagh and Ranchi districts, but the market figures above include these.

The principal stick-lac merchants and brokers are:—

Hukm Chand Haridit Ray of Jhalda and Ranchi
Mirzamal Marwari of Purulia and Jhalda
Jugalkishan Marwari of Purulia and Balarampur
Laxminarayan Gajhadhar of Balarampur
Khexidass Premdass of Balarampur
Nisikanta Banerji of Balarampur

and numerous others. These firms keep agents in most of the large and small bazaars and employ Baiparis who wander round the smaller

bazaars buying lac. They also send agents to the markets along the Bengal-Nagpur main line and to the Central Provinces at the time when the lac crops are coming into the markets. The method of sale of stick-lac in Jhalda is by open negotiation and in Balarampur and most other markets by the cloth method.

The following are the manufacturing centres showing number of factories, total number of stoves and possible daily output in maunds of shellac :—

Names	Number of factories	Total number of stoves.	Possible outturn in maunds of shellac.
Balarampur	27	400	300
Jhalda	15	150	110
Chandil	3	40	30
Chas	3	15	11
Purulia	3	40	30
Barabazar	2	25	18
Mitrah	1	10	7
Total	54	680	506

Working regularly, say 300 days a year, the factories in Manbhum district could turn out 1,50,000 maunds of shellac.

The principal manufacturers are :—

BALARAMPUR.

Hiralal Lalchand
Harnandan Rao Chuni Lal
Ratanlal Lunawat
Lachminarayan Surajmal
Surajmal Jiwanram
Baldeo Dass Surajprasad
Karikaran Bariram
Kakantlal Basantlal
Bechulal Baijulal
Gajhadhar Jaydayal

Ramdass Bhagwandass
Ganeshdass Baldeodass
Ghasiram Nagarmall
Ramdass Beharilal

JHALDA.

A. M. Aratoon
M. C. Gregory
S. J. Apcar
Kasi Prasad Bhairo Prasad
Atalbikari Haldar

PURULIA

A. M. Jordan

CHAS.

Ramdass Bhagwandass

CHANDIL.

S. P. Banerji

BARABAZAR.

Hari Kishendass, Marwari.

There is a small area of Government Protected Forest near Mahta. It is part of Chaibassa Forest Division and the lac is disposed of much as in zamindari areas; the total receipts, however, are only about Rs. 150 annually. The area is only important as a possible site for a Government brood farm as it is within easy reach of large lac-producing areas lying between Balarampur and Jhalda.

Manbhum, being the most important lac-producing district, calls for special action in order further to stimulate the industry. Several sites should be selected for brood farms, particularly one each in the neighbourhoods of Chas, Jhalda, Balarampur and Manbazar. No definite areas can be suggested but selection should not be difficult.

The manufacturers are fully alive to the importance of up-to-date mechanical apparatus, and in Jhalda and Purulia, where the industry is largely in the hands of Armenians, mechanical crushers and grain-lac washers have been installed and are giving satisfactory results. These manufacturers also show considerable enterprise in taking leases and propagating their own lac and experimenting with the formation of plantations of Ber.

SINGHBHUM.

Lac grows wild or is cultivated almost throughout this district. The principal species on which it grows are Kusum and Ber, but it also grows on Ruta (*Ougeinia dalbergioides*), Hesa (*Ficus Rumphii*), Lea (*Ficus glomerata*). Cultivation is in the hands of tenants, mostly of aboriginal races, who generally utilize trees (for which they pay no separate rents) on their home lands and gardens. For the cultivation of trees standing in village forests they pay two annas per tree to the village headman, who in Government Estates pays this amount into the treasury. When the lac crop is reaped the cultivators bring it into local markets and dispose of it to Baiparis, who practically rule the markets and are frequently agents of Arhatiyas and dealers in Chaibassa and Chakardarpur. The principal markets are at Chaibassa, Chakardarpur, Gamaria, Tatanagar, Jagannathpur and Jaintgarh. It is not possible to estimate the trade of each of these markets separately, but in a good year the total crops are about:—

	Maunds.
Kusmi	15,000
Jethwi	10,000
Baisakhi	30,000
Katki	25,000

The whole of this lac, however, does not come from Singhbhum district. About one-half comes from Mayurbhanj, Keonjhar and other Feudatory States.

The principal Arhatiyas and dealers are .—

Mithai Lal
Hiralal, Marwari
Jokhiram, Marwari
Sashi Bishun Kundu
Petambar Dalal
Hari Pada Datta
Kedar Datta
Ram Kamak Datta
Mangi Lal, Marwari.

Mithai Lal has a factory in Chakardarpur. Most of the lac from the district is sold to dealers and manufacturers from Balarampur.

The development of the industry in Singhbhum must depend largely on the action taken by the Forest Department, which controls extensive portions of the district, both as Reserved and Protected Forests, and at present obtains very little lac revenue from them. The question of allowing the cultivation of lac in the Protected Forests is worth raising, and, if direct cultivation by the Forest Department is not favoured, these forests might be thrown open for lac development by contractors or petty cultivators. The cultivation of the Reserves seems a possible source of income to the Department and it is suggested that the work be taken up departmentally as in Damoh. The possibilities of the Singhbhum district are great and the Forest Department of the Bihar and Orissa Government would seem to have an excellent opportunity of showing what can be done by improved methods, particularly as the Kusum tree abounds in all parts of the district.

Orissa Feudatory States.

Of the twenty-four States, the following produce lac:—

Athmalik, Gangpur, Dhenkanal, Keonjhar, Baud, Mayurbhanj, Pal-Lohara, Kalahandi; other States produce only small quantities. Orissa is a Kusum area, and, as one would expect, the more hilly portions are those which produce the lac. Kusum is in every State the most important tree, followed by Palas and Ber and the Ficus species.

The following are crop estimates based on recent years' averages as supplied by local authorities:—

	Maunds Annually.	
Athmalik ..	50	(Probably much greater in normal years).
Gangpur	3,500	
Dhenkanal ..	450	
Keonjhar ..	160	(Probably much greater in normal years).
Mayurbhanj .	1,800	
Kalahandi .	2,100	
	8,060	

The above figures are all conservative and based on recent outturns which in most parts of India have been poor. A fair estimate is probably 15,000 maunds in a good normal year, and this with improved methods might easily be doubled.

The method of collection varies in different States. In Athmalik a lease is given to a monopolist who employs daily labour for

propagation, collection, etc. In Gangpur any one may buy lac, but must obtain a license costing Rs. 50 in order to do so. The State reserves the right to fix a minimum price. As a method of ensuring the State share of the revenue, this system is very suitable, and by encouraging competition, it secures a fair rate to the cultivator. In Keonjhar there is a monopoly lease on a royalty basis, but a minimum total annual payment to the State is fixed. In Mayurbhanj State a monopoly lease is granted. The State has an organized Forest Department which encourages the cultivation of lac. The markets for lac are the railway stations along the B.-N. main line, particularly Chakardarpur (including Chaibassa) for Mayurbhanj and Keonjhar, Raj Gangpur for Gangpur, Raipur (Rajim) for Kalahandi.

The industry is capable of much extension throughout the Orissa States, which might well produce more Kusum lac than any other area in India. This is the largest area remaining in India without any railway, but the Bengal-Nagpur proposed branch Raipur-Vizagapatam will pass through Kalahandi and should stimulate the industry there; while the Sini Branch across Singhbhum will also undoubtedly stimulate production.

The State Durbars are fully alive to the importance of lac as a source of revenue, and are taking steps to encourage production backed up by the State Forest officials, particularly those of Mayurbhanj. At present cultivation is only on trees near the villages, and is rarely found in the remote jungles.

BILASPUR.

Roughly the northern half of the district produces lac, the southern half being open cultivated land with very few trees. Small clumps of Palas are to be seen occasionally in the fields, but the total number is too small to be of importance. Most of the lac area is included in the large zamindaris of Matin, Uprora, Pendra and Korba, and the principal tree is Palas.

The only important market is at Pendra on the Bilaspur-Katni branch railway. Good crops are, in clean maunds :—

Kusmi	...	...	...	2,000
Jethwi	...	..	...	500
Baisakhi	...	...	...	20,000
Katki	...	...	...	10,000

Markets of less importance are at Bilaspur, Champa, Raigarh (Feudatory State) and Akaltara, and a market is developing at Kota. These markets together produce about half the yield at Pendra.

The principal dealers in Pendra are:—

Manik Ram Mahadeo, Marwari
Somaru Ram Rambaros
Sita Ram Kanaiya Lal
Alladad Imam Din
Madhu Rangnandan Prasad, agent of Kashi Prasad, of Jhalda and Mirzapur.

There are no very large suppliers to the market. Sales are usually by open auction based on the *chaori* content.

The lac actually grown in Bilaspur is probably half the Pendra yield, the other half coming from the Feudatory States of Sirguja and Korea.

Very little lac cultivation is carried on in Government Forest. There are three Ranges, two of which, East and West Lormi, are unworked for lac; the third Pantora being leased out to a contractor for a small sum. He, however, has too little capital to be able to undertake much by way of extensions. The work should be taken over departmentally in all Ranges.

The zamindari system usually means the sale of the monopoly to a contractor. The zamindars of Matin and Pendra have revenue stations where royalty on export is collected at Rs. 2-2-0 per maund.

The chief problem in Bilaspur, as in most districts, is the supply of brood-lac. The large zamindaris of Matin, Uprora and Korba might be encouraged to start lac nurseries and a beginning might be made with Pendra which is under the Court of Wards. One large Malguzar, Khushal Singh of Kargi near Tendwa, is now extending cultivation and can supply brood-lac in the west of the district.

Raipur.

The Mahanadi river roughly divides Raipur district into plain and hills. To the west is the plain, open, cultivated land containing little tree growth and of no importance as a lac-producing area. East of the Mahanadi the country is hilly and generally well wooded, and in this area is to be found the bulk of the lac grown in the district. In the northern portion, lac is principally grown on Palas and in the southern on Kusum.

The principal markets in the district are at Rajim, Dhamtari and Arang. Dhamtari has a very important feeder bazaar at Balod in the neighbouring district of Drug. The annual outturn from these markets is, roughly, in maunds of clean stick-lac :—

	Kusmi.	*Jethwi.*	*Baisakhi.*	*Katki.*
Rajim ...	20,000	10,000	2,000	2,000
Dhamtari (including Balod) ...	10,000	5,000	1,000	1,000
Arang ...	5,000	2,000	2,000	1,000

These bazaars are therefore important principally for the Kusum lac they produce. The total quantity is small, but is capable of almost indefinite extension as the Kusum tree is very common throughout the whole tract and in the Feudatory States of Kanker, Bastar and Kalahandi, all of which supply lac to these markets.

Communications are very poor within the district, but the proposed railway from Raipur to Vizianagram will open up much of the eastern part of the district and will pass through Arang. If the Rajim line is extended to the south-east, it will undoubtedly stimulate the lac trade.

Most of the lac-producing areas are in the hands of large zamindars who give out annual monopoly leases to contractors. The latter take no interest in cultivation, but buy the lac from the cultivators at pre-arranged rates.

The system of sale in the big bazaars is generally by negotiation, the seller hawking samples round to the various buyers and selling to the highest bidder. Sales are generally by the clean bojha of 12 maunds (1 lac maund = 16 standard seers). A bojha is therefore 192 seers or approximately $4\frac{4}{5}$ standard maunds. Discount for stick and dust is always considered in fixing the price, but a new bojha of 5 maunds and 10 chattaks is starting in Rajim which is supposed to consist of—

Clean lac	...	...	...	...	192 seers
Dust	...	...	...	...	4 ,,
Stick	...	...	...	...	4 ,, 10 ch.

The principal regular buyers are agents from Mirzapur, Jhalda, Balarampur and Purulia. These are generally central collecting

agencies, and each will have a system of sub-agencies ramifying through all the small bazaars where lac is brought in by contractors, Baiparis and cultivators. Important sellers in the district are :—

Dhamtari—

Jamnadass Pannalal

Naraindin Jagganath

Rajim—

Bansi Lal Amirchand, Contractor of Giriaband Estate

Gopi Kishan Multani, Contractor of Kalahandi Feudatory State (Orissa).

There is one small factory in the district at Rajim, owned by Mr. Lucas.

There are several zamindaris under management of the Court of Wards. Kauria has been so managed for many years and a fair outturn of lac obtained. No scientific methods are employed as the staff is small and untrained. Sales have generally been by contract either on the monopoly system to the highest bidder or by royalty, the contractor paying so much per maund of lac exported.

Government Forests are very large and concentrated in two compact blocks, one in the north and one in the south, each under a Divisional Forest Officer. In 1905, when the Forests were all under one officer, an attempt was made to work lac departmentally. To provide labour many forest villages were started, the inducements being that tenants should receive three-fourths of the lac crop and Government one-fourth. The system was worked for several years, but eventually failed about the time when prices fell in 1908-09. The officer in charge retired about the same time and the industry has never been seriously revived.

However, a number of very useful lessons can be learnt from the records of this experiment. An enumeration was made of Kusum trees fit for infection. Twenty thousand were enumerated in two ranges (Laon and Sirpur) and it was estimated that there were 1,50,000 trees in the whole division. If each tree is infected once in three years, 50,000 trees might with intensive working be infected annually. A large Kusum tree has been known to give five to six maunds of stick-lac and the average in a good season is probably one maund. It is obvious, therefore, that the possibilities were great. The records show that about 15,000 trees were infected in 1907-09 for the Kusmi crop. Unfortunately the crop was very poor owing

to adverse climatic conditions and the ravages of the predatory moth, *Eublemma amabalis*, and averaged only 3½ lbs. per tree. The fates seem to have been against the Department throughout though it is also likely that, owing to the small size of the special staff entertained, the forests were largely at the mercy of lac thieves, who no doubt saw to it that the official yield was reduced to a minimum. The lac collected was sold by the local officials for Rs. 9-5-9 per 32 seers (or Rs. 11-11-2 per standard maund). At that time the Calcutta TN rate was Rs. 70 so that Kusum stick-lac at this period would be worth about Rs. 55 per maund. The lesson to be learnt is that unscrupulous middlemen may succeed in blocking competition at sales of Government stick-lac, and that such sales should only be held under the personal supervision of officers thoroughly acquainted with the market.

It is obvious that in the Government Forests of Raipur there is a very large potential supply of stick-lac which only awaits development. The local Forest Department is fully aware of this fact. Development will, however, require a well-trained staff and the system employed should be that which has proved so effective in Damoh, namely, direct departmental exploitation. The previous system was satisfactory so long as the cultivators' interest was retained by large profits. When a slump occurred in the market, and they got little return for their work, they naturally lost interest and successive crops were likely to fail. Had the work been wholly departmental, it would have continued, despite low profits, and the industry would have been ready for immediate extension as soon as the market recovered.

When the Forest Department has put the cultivation of lac on a secure footing, it will be able to supply brood-lac to outside cultivators in the neighbourhood. There are some parts of the district in the east and south-east which are 40 or 50 miles from the nearest forest, and it would be well to start brood farms in these neighbourhoods. No suitable places are known at present, but the Kusum tree is so common that areas could easily be selected. The big zamindars should be encouraged to form brood farms and Government might set the example in Kauria (Court of Wards) zamindari. The chief difficulties will be proper inspection and management, but with an adequate and efficient staff such as the project could well afford to maintain, these difficulties could be overcome.

Chattisgarh Feudatory States.

The States fall into three natural divisions, north, central, and south, and contain very important lac areas; they are still more important as potential sources of increased supplies.

The northern States, Changbhakar, Korea, Sirguja, Jashpur, Udaipur, Raigarh, Sakti, Sarangarh, and the central States, Kawardha, Chhuikhadan, Khairagarh, Nandgaon, are mainly Palas areas. The southern States, Kanker and Bastar, produce mainly Kusum lac. Subject to this generalization, both varieties come in varying proportions from all areas.

Yields are at present difficult to estimate, but the following is a fairly close, though conservative, annual estimate in maunds :—

	Kusmi	Jethwi	Baisakhi.	Katki
Changbhakar	Very	little	at present.	
Korea	200	100	10,000	6,000
Sirguja	...	...	5,000	2,200
Jashpur	50	50	...	...
Udaipur	Very	little	at present.	
Raigarh	1,200	800	400	600
Sakti	Very	little	at present	
Sarangarh	..		40	20
Kawardha	100	50	100	50
Chhuikhadan	Very	little	at present	
Khairagarh .			125	200
Nandgaon ...	10	10	20	20
Kanker	2,000	1,000	...	...
Bastar	500	200	..	.
Total	4,060	2,210	15,685	9,090

The important States are.—

Korea
Sirguja
Raigarh
Kanker
Bastar

though the remaining Feudatory Chiefs are also aware of the importance of lac and are endeavouring to stimulate the industry.

Korea.—Lac is produced everywhere except in the north and west of Kilhari circle and in Baghrondi circle ; that is to say everywhere except along the border of Changbhakar. The Durbar leases the right to cultivate in lots of a few villages. The principal local market is Baikunthpur whence the lac is exported to Pendra.

Raigarh.—The northern and hilly portion round Lailunga and Ghargoda produce Kusum lac, whilst immediately west of Raigarh town is the Palas area. The Durbar leases the right to collect a fixed royalty on exports of lac.

Sirguja.—There are four Tahsils in Sirguja State. Ambikapur produces a negligible quantity of lac, chiefly Kusum. The other three, Samri, Pal, and Chandni, are all full of Palas, and all produce quantities of lac The system of leasing is by petty annual contracts. The principal dealers are Mahadeo Choudri, Jorisahu Hiralal, and Narainsahu, all of P. O. Ambikapur, Sirguja State.

Kanker.—Lac is produced throughout the State, which is a very important supplier of Kusum lac. The Kusum tree abounds everywhere. The State Forest Department is responsible for the control of the industry and every effort is made to stimulate it. The State share of the profits is obtained by the moderate export royalty of Rs. 6-4-0 per maund. The whole of the stick-lac, which is of the finest quality grown in India, is marketed at Dhamtari, where there is considerable competition for its purchase, chiefly among buyers from Mirzapur.

Bastar.—The whole State is capable of producing lac, but cultivation is only in the north. The rest of the State is so far from the nearest market (Dhamtari) as to make cultivation unprofitable except when prices rule high.

Should a railway ever pass through the State a definite impetus will immediately be given to lac cultivation, and the possibilities of production of high grade lac are very great. Both Kusum and Palas are common trees everywhere, but the present cultivation is nearly all Kusum.

The principal markets are:—

Market.	*State.*
Sakdol .. .	Changbhakar
Pendra	Korea and Sirguja (south-west)
Daltonganj and Garhwa .	Sirguja (north-east)
Lohardaga .. .. Raj Gangpur ..	Jashpur
Raigarh	Udaipur, Sakti, Raigarh, Sarangarh and Sirguja.
Tilda .. .	Kawardha
Dongargarh . .. . Rajnandgaon ..	Chhuikhadan, Nandgaon and Khairagarh
Dhamtari	Kanker and Bastar

No action is proposed by Government Most of the States have their own trained Forest Staff and are aware of the importance of lac as a source of revenue; they may generally be relied upon to take the necessary steps to stimulate the industry.

Drug.

This district is small and not of very great importance. Lac, however, is found throughout the district except in the Drug Tahsil. The south-eastern part including the Balod Forest Range is chiefly Kusum, the remainder being mostly Palas.

The principal market is Balod which is included with Dhamtari in Raipur district. A certain quantity finds its way to Rajnandgaon (Feudatory State). The zamindar of Khujji has shown considerable interest in cultivation, which he has largely extended.

Government action is hardly necessary in this district. The Balod Range Forests are included in South Raipur Division (See Raipur notes) and arrangements can probably be made with Khujji to supply brood in that locality.

Bhandara.

Bhandara is an important district producing a particularly large and high grade Katki crop. The principal and almost only tree is Palas, which is found very abundantly in flat country on both sides of the narrow gauge railway from Gondia to Chanda and from Gondia northwards Most of this forest is malguzari and zamindari, and there are only small patches of Government Forest. The Forest

Department has been in the habit of leasing out the right to cultivate and collect lac, but on the expiry of the existing leases it is proposed to cultivate departmentally.

The only important market is Gondia, to which also lac comes from Balaghat, Mandla, Seoni, Chhindwara and Chanda districts. Balaghat sends about 5,000 maunds annually. The others much less. Good crops in Gondia are :—

	Maunds.
Baisakhi	40,000
Katki	50,000

Contracts are generally very petty and the contractors are usually of low caste and poor education, financed by dealers and brokers who naturally pocket most of the profits. Contracts are usually for five to ten years and are very simple agreements. The consequence is that during the recent boom, unsophisticated contractors were tricked out of their contracts They are now becoming more alive to their interests and are registering their contracts and taking legal advice. Cultivation is primitive in the extreme and the outturn could be largely increased by the introduction of improved methods. There is a good field for Government influence in demonstration and the supply of healthy brood-lac. A large area containing Palas should be acquired near Sonder or Dewalgaon Railway stations, and put in charge of the Forest Department, who with a staff of two or three men could control an area of 100 to 200 acres. This area would be managed as a brood farm and demonstration area and should result in at least doubling the present yield from Gondia market.

Alongside the Public Works roads and on the Bengal-Nagpur Railway embankments are large numbers of Palas trees at present uncultivated but to which lac has frequently spread by the agency of wind. It is understood that no revenue is at present obtained from these and it is suggested that leases should be offered to the public and development encouraged.

There are two small factories in Gondia owned by Mahibir Prasad Sundar Lal and Mahibir Prasad Ajodhya. They make TN shellac only. There is room for many more factories, but owing to there being no Kusmi available, only low grade shellac can be manufactured.

The principal Arhatiyas or commission agents are —

Jagannath Ghansilal

and

Ramgopal Suraf Baran.

As each new crop enters the market numerous agents and dealers come to Gondia from Mirzapur, Jhalda, Balarampur and even from Calcutta, to make their purchases, some also are permanently resident there.

Balaghat.

Cultivation is chiefly on Palas. The principal area is in the south-east adjoining Bhandara district. There are patches of lac elsewhere, but not many, and there is very little grown in Government Forest. The system of leasing and local conditions are similar to those in Bhandara district. The Forest Department is arranging for experiments to be made in a small area of forest used by the Forest School for practice purposes. No other Government action is required.

Balaghat district produces annually about 5,000 maunds of lac which is mostly sold in Gondia market.

Mandla.

Mandla is a wild and jungly district, practically undeveloped so far as lac is concerned The whole district is heavily wooded and there are large areas of Government Forest. A small quantity of lac is grown and numbers of small contracts are given out by Malguzars and by the Forest Department. The Kusum tree is fairly common in some parts of the North Mandla Forest Division and there are large areas of Palas forest, mostly however in Malguzari lands. On the expiry of the existing leases, the Forest Department proposes to take up lac cultivation departmentally. There will be no necessity for any action beyond that to be taken by the Department, which will be able to supply brood-lac and demonstrate methods of propagation and cultivation to owners of private forest The contractors employed at present take very little interest in actual cultivation and merely collect the lac from tenants who cultivate at will or collect lac where it grows wild.

The South Mandla Forest Division is mostly Sal and is of doubtful value as a lac-producing area. It would be advisable to make a rough survey to discover whether Kusum occurs in any abundance.

JUBBULPORE.

Jubbulpore district itself does not produce a large quantity of lac, but is of importance in that it contains one large (Katni) and several smaller markets, within its boundaries. The only areas growing lac are a few blocks of forest, Government and private, in the extreme north, and extreme south (Bargi) and along the Damoh border and the Mahanadi river. The principal species is the Ghont everywhere except along the Mahanadi where Palas replaces it. A number of Palas trees also grow along the Jubbulpore-Seoni road between Gawalighat and Hulki. The Public Works Department leases out the right to cultivate lac on these trees.

There is room for considerable extension of the industry in Jubbulpore district. Ghont, Ber and Palas are common and the example of the P. W. D. might be followed with advantage by the railway, whose embankments are frequently covered with a strong growth of Palas.

Besides the principal market at Katni, there are smaller markets at Sihora and Jubbulpore. A good season should yield the following crops, but it is to be understood that with extensions of cultivation the yield could be much increased :—

	Baisakhi.	Katki.	Kusmi	Jethwi.
Katni .. .	25,000	10,000	600	300
Sihora ..	5,000	2,000		
Jubbulpore	6,000	4,000	600	300

Not more than 10,000 maunds annually of this yield comes from Jubbulpore district. Large quantities come from the Malguzar forests of Damoh, Saugor and Mandla, and there is reason to believe that much lac is illegally removed across the borders from Rewah and other Central India States and from Damoh Government Forests. Katni also acts as a major market for much of the produce in the western districts of the Central Provinces, which each produce a small quantity of lac, namely Seoni, Chhindwara, Narsinghpur, Hoshangabad, Betul and Nimar. The system of collection is generally by lease to contractors. Madan Mohan Chaube of Katni-Marwara, a Malguzar, grows lac in his own forests and also takes

contracts. Most of the lac is brought in by Baiparis who buy from the small cultivators and lac thieves. Many contracts are made in villages along the borders merely to cloak thefts from Damoh, Rewah and other border States.

Lac, in Katni, is sold through Arhatiyas by the cloth method on *chaori* content. The Arhatiya, who takes Re. 1 per gon (3 maunds 30 seers) from the buyer and 6 or 8 annas per cent. from the seller, is generally a substantial merchant and often finances the wandering Baiparis He also very occasionally advances money to cultivators on the understanding that the latter sell their lac to or through himself. There are no large buyers permanently settled in Katni. Agents from Mirzapur, which takes the greater part of the yield, come to Katni for each crop.

There is no manufacture of shellac at Katni. Madan Mohan Chaube owns a factory which used to turn out 10 to 15 maunds of shellac daily, but it has been closed for many years Katni is quite a suitable site for a factory The water-supply would not be difficult and the climate is favourable. The stick-lac supply is ample in the neighbourhood, both from private lands and Government Forests. Ghont, the principal local tree, yields high class Baisakhi and Katki lacs. Kusum lac can also be obtained from the Raipur side, which is in direct communication by means of the Bengal-Nagpur Railway.

Supplies of brood-lac could be arranged by the Forest Department, which intends to cultivate departmentally in the Government Forest of this district as soon as staff is available. No other Government action is necessary.

Damoh.

Damoh is of interest as the centre of the Ghont lac area, and also as being the only district in which the Forest Department has seriously attempted lac cultivation

The forest is roughly divided equally between Government and private proprietors and both have met with considerable success in lac cultivation The Government Forests lie in the extreme north and in the southern half of the district. Around Damoh town the country is more open and contains less forest

All the lac grown in Malguzari forests is sold in Katni bazar. The Forest Department disposes of its lac by auction or negotiation.

The annual yield from private forests is about 3,000 maunds, chiefly Katki. The yield of Katki from Government Forest in 1919-20 was 4,500 maunds, the largest yet known. As the work has only been taken up seriously during the last two years it is very difficult to make an estimate of its ossibilities, but if conditions remain favourable it is likely that an annual crop of 10,000 maunds will eventually be reached. The principal difficulties to contend with are :—

(*a*) the supply of labour for propagation and collection

(*b*) the prevention of theft.

The recent boom in the price of lac has encouraged the organization of gangs of lac thieves in Damoh district, whose methods are said to be very efficient. The profits of their trade are so great that they are able to spend money lavishly in preparing for their exploits. One gang is credited with retaining a pleader to defend them against criminal charges. Experience has shown that the best way to defeat them is by a well-manned and well-paid protective staff, which will work in conjunction with the police. The Local Government has recently issued rules under section 41 of the Forest Act which will help in the detection of stolen lac in transit.

The private forests are worked either by contractors or by the owners themselves—usually men of substance who are sufficiently alive to their own interests to make proper provision for the supply of brood-lac. The Government Forests are ample and very suitable for the demonstration of improved methods. In 1919, owners of lac forests and others interested were invited to a demonstration of the methods employed by Government.

The principal growers of lac are :—

Goulal Chanda, Malguzar of Mariadoh

Pasan Kawat, Malguzar of Tendukhera

Nur Khan, Contractor of Damoh

The Raja of Hatri near Damoh.

SAUGOR.

The principal lac area in Saugor district is in the south and east along the Damoh border. The north-west (Khurai Tahsil) is more open country and contains much less tree growth. Ghont is the principal tree There are extensive Government Forests in the south and east and they include a large part of the lac area. During recent years the Forest Department has undertaken the cultivation

of lac. The work has not been so successful as in Damoh, possibly as the Ghont tree is nearing its apparent limit. The chief reason for the poor returns obtained seems to be the depredation of thieves, and the prevention of theft is one of the principal aims of the Department. Most of the remarks under Damoh district also apply to Saugor.

The Malguzari forests produce about 1,000 maunds of lac annually which is sold in Katni; and no action of Government is required to stimulate the industry in these forests.

NARSINGHPUR.

This is not an important lac district, but is interesting in that it contains three distinct areas where three different kinds of lac are grown. Palas occurs in the east of the district In the north is a small area which is a continuation of the Saugor-Damoh plateau and in which Ghont is the host-tree. In the south-west, round Mohpani, Kusum lac is produced, this tract forming part of the small Kusum area in Hoshangabad and Chhindwara districts which feeds the Bankheri market. Bankheri is a small market just within the Hoshangabad district in which chiefly Kusum lac is sold. Good crops are :—

	Maunds
Kusmi ...	3,000
Jethwi	2,000
Baisakhi	2,000
Kathi	1,000

A small quantity of lac is also sold at Narsinghpur. The principal suppliers at Bankheri are Girdhari Lal of Dongarhai, Hoshangabad district, and Onkar Prasad and Dhan Singh of Bankheri. The principal buyers are from Mirzapur. Lac comes chiefly from extensive private forests in all three districts, and also a small quantity from the Khairi Forest Range. Lac from the rest of the district goes to Narsinghpur and Jubbulpore.

The possibilities of this district are not great, but lac should be cultivated systematically in the three small patches of Government Forest which can then supply the brood-lac requirements of the district.

DISTRICTS OF MINOR IMPORTANCE IN THE CENTRAL PROVINCES.

Nagpur, Wardha, Seoni, Chhindwara, Hoshangabad, Nimar, Betul and the Berar Districts.

Lac grows sporadically in most of these districts. Either ignorance or adverse climatic conditions or a combination of both are probably responsible for the fact that more is not grown. Spasmodic attempts have been made by the Forest Department to extend cultivation, but all have failed. A determined effort was made in central and western Hoshangabad in 1910-13 by an officer well acquainted with the cultivation of lac, but he met with little success. Of the Berar districts only the Melghat Forest Division in the Amraoti district produces much lac, and here there is most likelihood of extension by departmental cultivation. Attempts will probably again be made by the Forest Department when more staff is available, but at present their efforts should be concentrated in districts which offer more hope of success.

REWAH STATE.

Lac is found over the whole of the southern half of this State but about 80 per cent. of the outturn is from the two tahsils which lie along the Bengal-Nagpur branch railway from Katni to Bilaspur, the Chandia and Sohapur Tahsils. The yield has varied during past years from 53,000 maunds in 1913-14 to 12,000 maunds in 1917-18. Of this yield an average of 5 to 6 per cent. is grown on the Kusum tree, the balance being almost entirely Palas, and the Baisakhi crop is somewhat larger than the Katki.

The centre of the industry is at Umaria Railway station on the Bengal-Nagpur branch line, which passes through the middle of this lac area. The industry is thus very well placed in regard to rail transport, and in fact all conditions in the State are favourable to its propagation The climate is suitable and the Palas and the Kusum are both royal trees, which means that, wherever they stand, those trees are the property of the State. As a corollary, all lac is the property of the State and control should, therefore, be very easy. The lac industry is in charge of the State Forest Department and the principal difficulties the Durbar has to contend with are the provision of an efficient and trained staff and the prevention of theft.

Without exaggeration there must be millions of Palas trees scattered over the two southern tahsils, and it is unquestionable that the production of lac might be increased almost indefinitely if sufficient staff and labour could be provided Labour is none too plentiful but with such labour as is available the annual outturn in a good year might be raised to 100,000 maunds if control were efficient. Effective control must include the prevention of smuggling across the boundary, for lac theft is rife in this part of India and probably causes a very heavy annual loss to the State. It is difficult to suggest a remedy, but the State is no doubt making every possible effort to prevent illicit removals.

The system employed by the Forest Department is direct departmental cultivation. The ultimate unit is a *lakhera* (lac plot) in charge of a *lactora* (lac cultivator). Theoretically the system of cultivation adopted is scientific, but owing to a shortage of trained staff the practical result is the survival of primitive methods. The *lactora* is responsible for the propagation, protection and collection of lac within his area and receives as his pay 2 annas per seer of lac produced.

The State has a very well built and equipped shellac factory at Umaria, capable of dealing with all the lac produced within its jurisdiction. The methods employed are similar to those in Mirzapur and Balarampur. The quality of shellac produced approximates to TN standard The manufactured article is disposed of in Calcutta.

UNITED PROVINCES.

The United Provinces are comparatively unimportant as lac growing areas It seems likely that in early days the province produced much larger quantities than at present, but field cultivation has become so intense that little culturable land remains uncleared and the demand for fuel has become so great that what little waste land there is has been more or less cleared of trees. The possiblities of the extension of lac cultivation are therefore not great, and what cultivation exists is so scattered that there is little hope of development except in the south of Mirzapur district, which is dealt with separately. Apart from Mirzapur the more important areas are Bahraich, Gonda, Kheri, Shahjahanpur, Lucknow, Cawnpore, Saharanpur, Aligarh, Bareilly, Meerut and Moradabad.

The principal trees in the U. P. on which lac grows are Palas, Pipal, Banyan and Ber. A small quantity is said to be grown on the

Kusum tree in Kheri district. The methods of cultivation are primitive. The system is usually one by which contractors do the work of propagation, cultivation and collection by daily labour.

The principal markets and good crops are :—

	Baisakhi	Katki.
Mathera (Bahraich)	2,000	3,000
Rissia (Do.)		
Hatras (Aligarh)	1,000	1,000
Lucknow	1,000	1,000
Singai (Kheri)	2,000	2,000
Cawnpore	1,000	1,000
Saharanpur	3,000	2,000
Bareilly	3,000	1,000

The figures given above are admittedly approximations only.

The principal dealers are :—

Mathera.—Mangal Ram Narayan.

Rissia.—Kalicharan.

Lucknow.—Haji Elahi Bakhsh Sharif Uddin.

Cawnpore.—Moolchand Bania (Bhoosa Toli). Lachman Dass Jagannath (Nanghara).

Bareilly.—Sibba Manhar (Mohalla Nala). Nanha Manhar (Mohalla Akub Kotwali).

There is one shellac factory at Cawnpore belonging to Salikram Kalloomal of Baconganj, who manufactures TN chiefly. He takes large quantities and the balance goes to Mirzapur whence buyers come at the crop periods.

Attempts have been repeatedly made by the Forest Department in various districts to extend the cultivation of lac, particularly on Palas, but they have not met with any success.

Cultivation can never be very extensive or very important in the U. P. and for this reason Government action is hardly called for, except for any experiment which the Forest Department may care to undertake. If such experiments prove successful the question can be reopened.

MIRZAPUR.

Mirzapur is chiefly of importance as the largest lac-manufacturing centre in India. The bulk of the district produces no lac, but the area south of the Sone river produces considerable quantities. This area naturally forms part of the Palamau district of Bihar and Orissa In racial and other characteristics both areas are similar, and Mirzapur stick-lac finds its way mostly to Garhwa Road station on the Daltonganj branch railway, Palamau In fact it is impossible to distinguish Mirzapur lac from that of Palamau. Only a small quantity of the former finds its way to Ahraura station on the East Indian Railway main line.

The system of cultivation in Mirzapur is the usual very primitive method. The principal tree is Palas with a little Ber and some other trees. The cultivation is generally by individual tenants and not by contractors, each tenant cultivating his own few trees in his own interest. A large part of Mirzapur district south of the Sone river is Government Estate and the forest is largely Government Protected Forest managed by the Revenue staff. Here only lies any possibility of improvement of cultivation by Government action, but it is very difficult to suggest means It is an isolated area with a small forest staff. It is hardly worth while taking any special action such as the formation of brood farms or the appointment of a special scientific staff and the area will have to depend for brood and demonstration on such action as may be taken by the local authorities in Palamau.

The chapters relating to manufacture and to the internal trade of India describe the ordinary lines of business as conducted at Mirzapur. A feature of the trade is the Chapra Vyapar Bardhini Sabha, or "Association for the Improvement of the Shellac Trade," which has existed for some years past at Mirzapur. The membership roll includes the names of some eighty-four firms in all, representative of dealers and brokers, as well as of the fifty odd local manufacturers. The principal object of the Association is the decision of disputes between members The executive committee passes orders on such disputes, but also refers to a meeting of the general committee any point of special importance requiring their decision, naturally, however, such references are not numerous. It is also the business of the executive committee to draw samples every six months, and to give their official sanction to these as standard samples of the incoming crop.

The following is a list of the principal manufacturers of shellac in Mirzapur :—

Kilburn & Company
C J. Lucas
John Edmond & Co.
Mahadeo Prasad Kashi Prasad
Gopaldas Kandhaiyalal
Dhansukhdas Jethmal
Hiralal Jhabbulal
Garibram Chhedilal
Baldeodas Sarju Prasad
Madan Chand Gangadhar
Kandhaiyalal Onkarnath
Ghasiram Baldeodas
Baijnath Bhagwandas
Balkrishna Jagannath
Mannalal Bhagwandas
Balairam Jokhairam
Aladad Imamuddin
Ghosh Mohammad Khairuddin
Bindraban Mahadeo
Radha Raman Agarwala
Bhuddulal Rang Lal
Shaik Abdul Karim
Ganesh Prasad Narayan Das
Haridas Balramdas.

The following are the principal Arhatiyas and dealers in stick-lac.—

Jamunadas Panna Lal
Lachhman Das Manrakhan Lal
Ghasiram Baldeo Das
Lachhmi Narayan Hanuman Das
Jitmal Girdhari Lal
Anant Ram Sajan Kumar
Hiralal Jhabbulal.
Seth Sewaram Khushhal Chand
Ram Lal Makund Lal
Gobind Ram Sita Ram.

Brokers —
Hardas Agarwala
Badri Prasad Tiwari
Gaya Prasad Agarwala
Maheshilal Agarwala
Ganpatlal Marwari
Lachhmi Narayan
Manni Ram Pande
Gopaldas Agarwala
Kandhaiyalal Marwari
Shambhulal Khatri
Haridas Khatri
Madan Lal Khatri
Bulakiram Agarwala
Ajodhia Prasad Bania
Chhedilal Khatri
Ram Sunder Pande
Munni Lal Chaube

Shellac Exporters (Commission Agents):—
Dhansukhdas Jethmal
Gopal Das Kandhaiya Lal
Kishun Prasad Bisun Prasad
Mohan Lal Onkarmul
Ganesh Das Hardat Rai.

PUNJAB.

With the exception of one district, this province is of no importance as a lac producer. Small quantities are produced in Amritsar, Delhi, Guzerat and Karnal and perhaps other districts, but the province as a whole has climatic conditions too extreme for the successful propagation of lac. The exception, Hoshiarpur district, is a distinct anomaly and produces quantities of lac of some importance to the trade. The lac-bearing areas are principally in the Una Tahsil with smaller areas in Dasuya and Garh Shankar but very little in Hoshiarpur Tahsil. A small quantity also comes to Hoshiarpur market from Nadaun in Kangra district. The apparent cause of this anomalous growth of lac is the existence of the Siwalik Hills between which and the Himalayas lies the lac-bearing area, a long narrow valley along which flow tributaries of the Sutlej and Beas rivers. The Siwalik

Hills run from north-west to south-east and the valley is shut in to the south-east by the Simla Hills and to the north-west by the Kashmir Hills, and is therefore protected on all four sides. One would naturally expect to find special climatic conditions ruling in such a locality. The rainfall in Una Tahsil is certainly greater than at Hoshiarpur outside the valley, which must in general enjoy a somewhat more favourable climate than is to be found in the more exposed portions of the district. It is at present only surmise that the Una Tahsil owes its lac to these peculiar conditions, but this seems to be the natural conclusion.

The principal lac-growing species is Ber which exists, or has been sown specially for the purpose, round the village sites. Small quantities are also grown on Babul and Ficus spp. The cultivation is much the same as elsewhere, a few trees being always reserved for brood. There appears to be no difficulty about brood-lac and the industry seems to be thriving. The actual work is done by the landowners. They sell their lac to Baiparis who bring it to Hoshiarpur for sale, chiefly to agents of Mirzapur and Imamganj firms who come to make their purchases each season.

Good crops are —

	Maunds.
Baisakhi	15,000
Katki .	10,000

The basis of sale is the local lac maund of 54 seers 2 chattaks. The odd two chattaks are the perquisite of the buyer's agent. The Arhatiya recovers two pice per rupee from the seller and 1 per cent. from the buyer.

The principal Arhatiyas are :—

L. Thakur Dass
L. Mukunda Mall
L. Gujar Mal Mikki Ram
Birja Mal Teghu Mal
Gurdita Mal Md. Baksh
Rup Ram Balik Ram
Sri Kishan Dass Bansi Lal.

The only known contractor is Ghulami Kasi, District Board Contractor.

There is no manufacture of shellac in Hoshiarpur. Local wood and metal workers import an insignificant quantity from Mirzapur.

The existing Kangra Forest Division includes the small areas of Government Forest in Hoshiarpur district. It is proposed to divide the whole division into two, and a Forest Officer may then be posted to Hoshiarpur. In this case the Forest Department will be able to study the question of lac cultivation in more detail than has been possible till now. If sufficient trees occur in Government Forest, the demonstration of scientific cultivation and the provision of clean brood-lac to private cultivators at reasonable prices will undoubtedly stimulate the industry and prove of considerable profit to the Department.

Bombay Presidency.

In Bombay Presidency proper, lac is at present of very little importance. Small quantities are grown in Khandesh, the Dangs and the Panch Mahals, and in adjoining territories of Baroda and other States, but the total amount grown is unimportant.

Sind, however, produces lac on a scale of considerable importance to the trade. It is mostly grown in the two districts, Hyderabad and Karachi, on both sides of the lower Indus. Sind is usually considered one of the hottest and dryest parts of India. This being so, the occurrence of lac there must be regarded as somewhat of an anomaly. A suggested explanation is that on the lower Indus sea-breezes during the hot weather do much to reduce the severity of the climate. No definite reason can however be assigned without careful local investigation.

Another curious fact about Sind lac is that it is mostly grown on the Babul tree, which, except sporadically in the Punjab, is found nowhere else in India as an important lac-host Possible explanations of this have been discussed in Chapter II. Lac is also grown on *Prosopis spicigera*, *Zizyphus Jujuba*, *Albizzia Lebbek*, *Tamarix gallica* and *Ficus* species, but these are all of comparative unimportance compared with Babul. The methods of propagation, cultivation and collection are much as in other parts of India, but the times of swarming are somewhat later.

The principal contractors and dealers are :—

Akhund Hassanali of Matiari, Hyderabad

Rewachand Permanand of Hyderabad

Gobinbax Hassomal of Hyderabad

Sajan Mohamed Hashim of Matiari

Chatomal Metholal of Hyderabad

Deomal Sadarangani of Hyderabad.

Most of the lac is grown on private lands.

The average outturn from the Government Forests of Hyderabad and Jerruck Divisions is about 1,000 maunds, while the Public Works Department obtains almost as much from lands in its charge. Contracts are usually given and there is little departmental cultivation. The total outturn of Sind is supposed to be about 20,000 maunds Baisakhi and 6,000 maunds Katki annually, but these figures are not very reliable. The greater part of this lac is exported to Mirzapur for shellac manufacture, but before the war an average of 5,500 maunds of grain-lac was manufactured at Hyderabad and exported from Karachi, the principal exporters being Messrs. Donald Graham and Co., and Messrs. Ralli Bros.

The quality of Sind lac is hardly equal to the Indian Baisakhi and Katki, but is better than either Assam or Burma lac and is suitable for TN manufacture.

Government Forests have been in the habit of supplying brood-lac when required. It is suggested that they might now go further and experiment with departmental cultivation.

BENGAL.

The only important areas in the Bengal Presidency, as now constituted, are the extensions of the Sonthal Parganas (Pakaur) area into Malda, Murshidabad and Birbhum districts, and of the Manbhum area into Bankura and Midnapur.

The Malda lac area is a fringe along the Ganges. In Murshidabad, the Jangipur sub-division produces a large quantity of lac and it occurs scattered in other parts of the district. In Birbhum, the northern part of the district produces most lac. Pakaur forms the centre of the lac industry for all these areas, with subsidiary markets at Dhulian, Jangipur, etc.

A fair quantity of lac is grown in the west of Bankura and Midnapur adjoining Manbhum and it grows sporadically in many other parts of these districts. Apparently the cultivation of lac was once on a much larger scale, as the Bengal administration report of 1901-02 states that "the manufacture of shellac is an important industry in the Bankura district and is chiefly carried on in the town of Sonamukhi"—"the main supply of this article for all the factories

in Bankura is obtained from the districts of the Chota Nagpur Division." During the last decade this industry has almost disappeared. The reasons are probably that the factories at Sonamukhi could not compete with the Chota Nagpur factories, that the cultivation being near its limit was precarious, and that Palas trees were cut down as field cultivation intensified. The district officials are, however, hopeful that the industry will revive.

The principal host-tree is Ber, almost exclusively in Murshidabad but mixed with Palas and other species in other districts, and with a little Kusum in Bankura. The methods of cultivation are as in the Sonthal Parganas and Manbhum, but in Murshidabad and Makda the cultivators are of a higher class and are more careful to maintain the brood which they also supply in large quantities to the Sonthal Parganas. It is probable that the methods of cultivation in the Jangaipur sub-division are as good as anywhere else and a proper rotation of trees is really attempted. Cultivation is also very intense, particularly in Murshidabad, and these Bengal districts supply the greater part of the lac in Pakaur market. The following cultivators in Murshidabad district are said to produce over 100 maunds each annually :—

Mohammad Bogdad Biswas, Shahebnagore
Hazi Basti Mandal, Debidaspur
Rahahak Biswas, Ghaneshyampur
Hedatulla Biswas, Shutitala
Ahasadtulla Biswas, Babupur
Jafar Munsi, Haripur
Bholai Biswas, Jote Kashi
Jagir Munshi, Shikdarpur
Madhusudan Shaha, Kohatpur
Rajendra Nath Shaha, Kohatpur
Adhar Shaha, Kakwira
Hazi Jatra Monim, Chachanda
Golap Monim, Chachanda
Umesh Mandal, Basudebpur
Isan Mandal, Jaladipur
Kifatulla Mandal, Loharpur
Moharkhan, Harinandanpur
Bhaglu Mandal, Harinandanpur

Jadunath Das, Faridpur.
Ashutosh Tewari, Sherpur.

No Government action is proposed in this area as cultivation appears to be based on sounder principles than elsewhere. The Pakaur area will benefit from any action taken in the Sonthal Parganas and the Bankura area from any in Manbhum.

Calcutta is an important manufacturing centre, the largest machine manufacturers having their factories there. They are :—

Messrs. Angelo Bros., Cossipore
J. C. Galstaun, Esq., Calcutta.

A considerable stick-lac market exists in Calcutta for the supply of these factories. The bulk of this lac has, however, already passed through one or other of the up-country markets, except the Assam and Burma lac, of which these factories take almost the whole supply. Being the shellac market of India, Calcutta is very convenient as a site for lac factories, but on account of the high price of labour, distance from the stick-lac centres, and high humidity which necessitates special precaution against the blocking of stick-lac and shellac, it cannot be recommended.

ASSAM.

The position of lac in Assam is unique in that it is not, as elsewhere, a forest product, but is grown chiefly on a field plant, Arhar Dal. Assam has a large rainfall and considerable falls occur during the hot weather months, especially in the hills, so that Arhar, which is an annual elsewhere in India, persists for several years, and is able to bear a crop of lac. Certain forest trees also produce lac, notably *Ficus religiosa* (Pipal) and *Ficus infectoria* (Pakri), but the bulk of the Assam lac is grown on Arhar. The distribution is mainly in the hilly tracts, and it seems as if the plains are too humid for lac cultivation. It may be seen well distributed on the hills in the territories of the Raja of Rambrai (Khasi Hills). The following areas produce lac and the quantities given are normal average yields :—

	Maunds.
Khasi and Jaintia Hills	15,000
Garo Hills	9,000
Nowgong district	7,000
Kamrup ,, ...	3,000
Sibsagar ,, ...	1,000
Total ...	35,000

The winter and summer crops are known locally as Katwan and Jethwi, from the months in which the crops are generally collected. Jethwi is used principally as a brood crop and the amount which reaches the market is small (about 5,000 maunds on an average) compared with Katwan (about 30,000 maunds). An insignificant quantity of the lac is imported into Assam from Bhutan.

Most of the Assam lac is cultivated by aboriginal tribes on the hills by shifting cultivation, locally known as "jhuming." Jungle is cut down and burnt, and Arhar Dal is sown in the burnt soil. The plants are allowed to attain one year's growth and are then infected. After the collection of the lac, the plant sprouts again and a second lac crop can be reaped a year later. As the host only persists for a few years, regular infection is obligatory, and hence more thorough than in India. The practice of infecting by small quantities of brood-lac, which are left for a season or two to reproduce naturally and thus fully infect the host, is not possible. After the death of the host, "jhuming" is carried on to a fresh area, where cultivation is repeated; and the result tends to the destruction of the forest.

The cultivators take their lac in small quantities to the small bazaars at the foot of the hill and dispose of it to Garo and other traders, generally in exchange for opium and salt, cloth and (more rarely) cash. Opium is the commonest. Naturally the cultivator gets very much the worst of the bargain, and only when prices are very low does he get anything like his proper share of the proceeds. He is generally indebted to the trader who is thus able to pay his own price for the lac.

The traders send their lac to the big export markets, principally Barapani (Nowgong) and Palasbari (Kamrup) whence it is despatched by train or steamer to Calcutta. The principal subsidiary markets are—in the Nowgong area: Kalanga, Lopani, Meragar, Katri, Jogi, Nilihat, Nekra; in Sibsagar area: Golahat, Dimapur, Bartalawa, Birkarkhat; in the Garo Hills: Tura, Dubri, Damra; in the Kamrup area: Boklu, Singra, Goalpara, Jaintiapur.

The largest dealers are:—

Joynarain Goadhan Agarwala, 94, Lower Chitpore Rd., Calcutta, whose local office is Joynarain Sonairam of Gauhati

Nandram Bhairondan of Barapani, Nowgong

Lakmi Chand Gulab Chand of Lopani

Gewar Chand Dharam Chand of Lopani

Budaimal Pannalal of Barapani

Ansukra Bala Baksh of Kalanga near Barapani

Chot Mal Malab Chand of Lopani and Meragar Baghicha.

There is no manufacture in Assam. Years ago a planter, Mr. Beecher, started a factory at Gauhati which closed down on his decease. Assam lac is produced in fine large incrustations, but is not up to Indian lac either in colour or quality, although it is considerably superior to Burma lac. It is not usually used for TN manufacture except when demand is high and the Indian crop is poor. The Calcutta manufacturers take most of the crop and it is said to be particularly suitable for making garnet lac.

Prior to 1914, lac was classed as a forest product and the Forest Department realized an export duty of Rs. 2 per maund (calculated to represent 12½ per cent. *ad valorem*). Mainly owing to protests from the trade the duty was removed in 1914, with the object thereby of stimulating cultivation. This effect has not, however, been secured to judge from the Assam export figures below.

So far as Government lands are concerned the right to collect lac revenue was leased out until 1907; and between 1907 and 1914 the revenue was collected departmentally. Neither method was, however, found satisfactory. A small quantity of lac is grown in lands under permanent settlement and in Government leased lands (raiyatwari) but it is insignificant. Government's share of lac revenue is included in the rents fixed at settlement and Government has therefore never claimed a separate lac revenue from these areas.

The Forest Department is thus no longer directly interested in the crop. It is suggested that either this Department or the local departments of Agriculture or Industries should take such measures as are possible to study cultivation and to stimulate the adoption of up-to-date methods. The practice of "jhuming," which is most frequently found to occur in unclassed forest and Feudatory States, might with advantage be discouraged in favour of cultivation on sounder and more permanent lines.

The statement below shows the exports of lac by rail and river from Assam from 1899-1900 to 1918-19. There are no exports from Assam across the frontier :—

Years.	Exports Cwts
1899-1900	11,276
1900-01	13,363
1901-02	22,597
1902-03	21,830
1903-04	24,121
1904-05	28,643
1905-06	26,753
* 1906 07	33,162
* 1907-08	32,700
* 1908-09	11,051
* 1909-10	35,386
* 1910 11	31,618
* 1911-12	30,762
1912-13	26,092
1913-14	19,787
1914-15	21,717
1915-16	37,467
1916-17	23,842
1917-18	15,692
1918-19	27,091

Burma.

Burma lac has been for many years of some considerable importance to the trade. It contains a high proportion of colouring matter and was prized in early days by the manufacturers of lac-dye. Unfortunately, this detracts from its value as the raw material for the manufacture of shellac Comparatively little has ever been exported to foreign countries direct, either in the crude or manufactured state, and it is now principally shipped to Calcutta on order from manufacturers using mechanical processes; but, when the Indian crop is short, TN manufacturers also buy Burma Lac, to blend with Baisakhi and Katki.

* These figures relate to the province of Eastern Bengal and Assam as it was constituted after the partition of Bengal.

The following table shows the shipments of Burma lac to Calcutta during each of the years 1866-67 to 1919-20:—

Year.	Cwts.	Year	Cwts.
1866-67	1,483	1894-95	10,836
1867-68	545	1895-96	24,369
1868-69	1,593	1896-97	9,330
1869-70	460	1897-98	10,884
1870-71	588	1898-99	8,630
1871-72	*Nil*	1899-1900	9,290
1872-73	3,906	1900-01	11,027
1873-74	*21,483*	*1901-02*	*15,108*
1874 75	14,893	1902-03	21,668
1875-76	4,216	1903-04	30,797
1876-77	8,594	1904-05	24,703
1877 78	4,343	1905-06	26,715
1878-79	Not issued.	1906-07	27,214
1879-80	6,203	1907-08	14,259
1880-81	11,499	1908-09	21,292
1881-82	6,999	1909-10	15,081
1882-83	3,781	1910-11	27,284
1883-84	4,370	1911-12	1,777
1884-85	1,649	1912-13	9,454
1885-86	2,926	1913-14	6,359
1886-87	3,052	1914-15	2,964
1887-88	2,919	1915-16	19,346
1888-89	3,805	1916-17	24,347
1889-90	2,244	1917-18	15,817
1890-91	4,655	1918-19	18,559
1891-92	5,923	1919-20	45,036
1892-93	9,063		
1893-94	11,663		

There was a marked decrease in exports during the decade 1881—1890, when the lac-dye industry was expiring and shellac had not yet come to its own. It is also noticeable that when the Calcutta shellac market is depressed, the shipments from Burma to Calcutta almost disappear, but increase when the market revives. Thus in the four years 1904—07, when prices were high, the average annual exports to Calcutta exceeded 25,000 cwts. In 1913-14 and 1914-15, when Calcutta prices were low (Rs. 30—40 per maund), Burma shipments were only 6,359 cwts and 2,964 cwts. During the three following years, when prices rose materially to Rs. 80—100, shipments were in the neighbourhood of 20,000 cwts. per annum.

Distribution follows two more or less definite zones, one lying along the eastern slopes of the Arakan Yoma and the other in the hilly country of the Northern and Southern Shan States. In the former it is known to occur in Henzada, Prome, Thayetmyo, Minbu, Pakokku, Chindwin, Katha and Bhamo districts, and probably occurs in others too The Irrawady river forms the main line of export to Rangoon. Many of the Shan States produce lac, Hsipaw and Maymyo being the centres in the Northern, and Taungyi in the Southern Shan States. These States have very poor communications and the actual distribution is unknown, but is undoubtedly widely spread, for lac even enters them from China, Thibet and Siam.

There is very little lac cultivation in Burma, most of it growing wild. In Henzada district it grows only on the tops of the hills above 2,200 feet in most inaccessible places and very scattered. The principal host-trees are *Pentacme suavis* (Thitya), *Shorea obtusa* (Ingyin), *Dalbergia cultrata* (Yindaik), *Aporosa Roxburghii* (Yemein), *Dipterocarpus tuberculatus* (In), *Croton oblongifolius* (Thetyingyi) and *Ficus spp.* In this tract the crop usually has an injurious effect on the trees, for it is only collected spasmodically and brood after brood emerge and cover every available part of the tree with lac, which exhausts its energies and results in its death. Further north and in the Shan States, lac grows also on *Butea frondosa* (Pauk) and *Zizyphus Jujuba* (Zi) and is found there at lower altitudes than in Henzada.

Some confusion has occasionally arisen between lac and Burmese lacquer. The latter is a gum obtained by tapping *Melanorrhœa*

usitata, locally known as Thetsi, and is quite different from lac. Stick-lac is known as *chaik* and *binli* lac as *chaiktha*. The trade is mostly in the hands of Chinamen, who in the usual course take contracts from the Forest Department and send their agents to the forests to collect from the local Burmese. One Chinaman is said to be growing lac on Arhar *Cajanus indicus* (pe-singon).

Most of the lac is brought in by Chinese merchants carrying on their business in Tsee Kai Maung Taulay Street, Rangoon. Messrs. Martin and Co., Ltd., 10 Strand Road, are also interested in the industry. Two firms, The Eastern Lac Refinery Co., Ltd., and the Burma Lac Refinery Co., Ltd., commenced manufacture in Rangoon, but both were wound up before the war. Mr. Apcar of Maymyo makes grain-lac on a small scale. Unless a better quality stick-lac can be produced it is very doubtful whether shellac factories will be financially successful except at periods when trade booms.

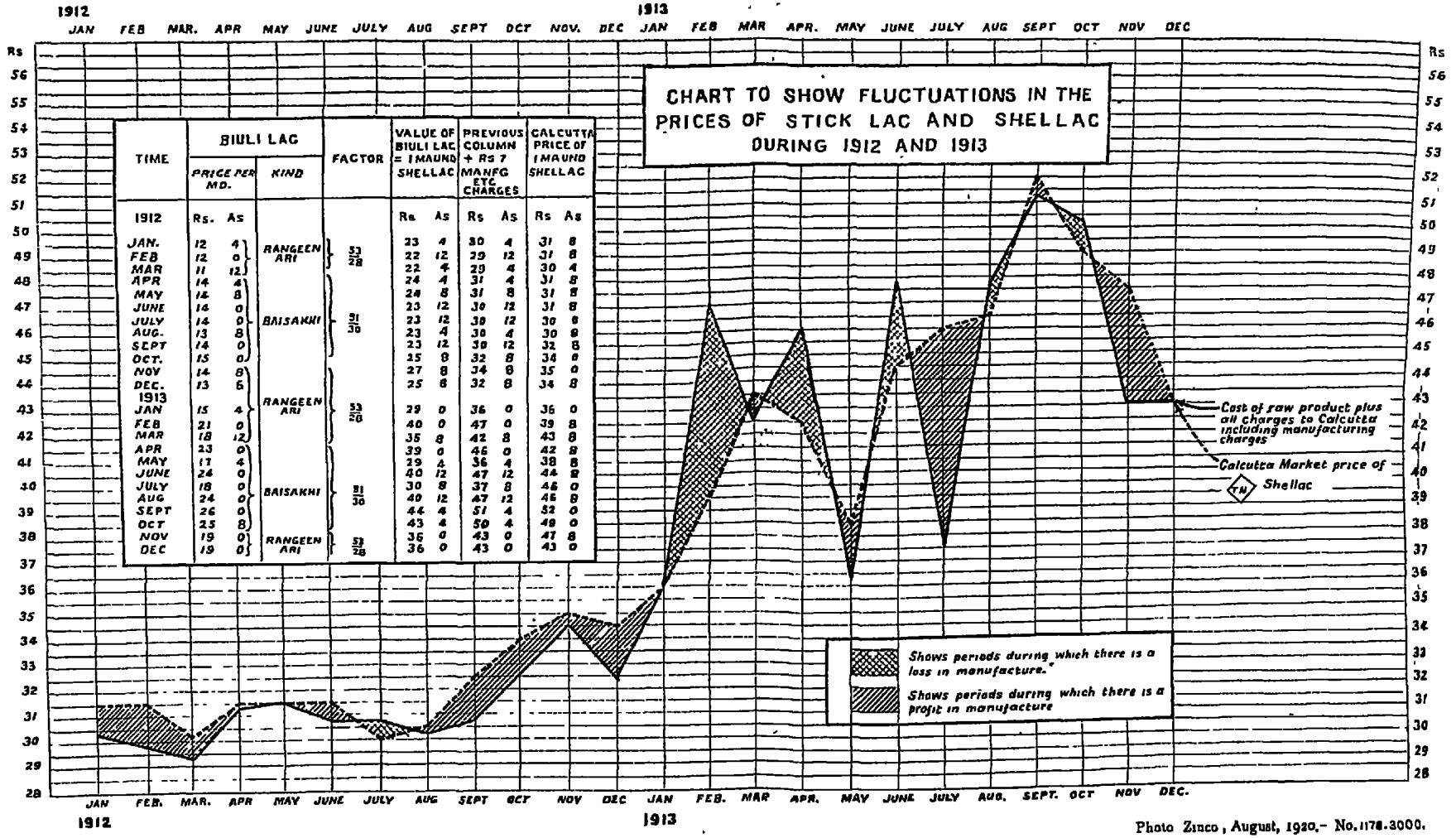
The principal exporters of stick-lac in Rangoon are:—

H. Palladioy, 51, Merchant Street
Naitram Rambar, 2 Mogul Street
M. T. Lutman Narayan, 3 Merchant Street
N. Jugganath, 1 Mogul Street
B. Rung Lall, 46 Strand Road.

As already stated, Burma lac contains a large quantity of lac-dye; and the resin itself, besides being more highly coloured, is of much poorer general quality than the Indian product. These defects seem to be inherent and due to climate or locality and it is very doubtful if Burma can ever produce higher grade lac. It follows that the demand for it is never likely to be constant as all manufacturers, including those who have adopted mechanical processes, prefer Indian lac if they can get it. As there is great hope of increasing the Indian supply considerably, attempts to extend the industry in Burma are not likely to be successful.

Only a small revenue is obtained by the Forest Department from contracts for lac collection, in addition to the export duty of Re. 1 per maund which is collected by the Custom-house at Rangoon and credited to the Department.

An interesting fact is that Kusum, locally known as Gyo, is quite common in Burma, and is almost regarded as a weed in the forests. No lac was found growing on this tree, which produces



TIME	BIULI LAC			FACTOR	VALUE OF BIULI LAC = 1 MAUND SHELLAC		PREVIOUS COLUMN + Rs 7 MANFG ETC CHARGES		CALCUTTA PRICE OF 1 MAUND SHELLAC	
	PRICE PER MD.		KIND							
1912	Rs.	As			Rs	As	Rs	As	Rs	As
JAN.	12	4	RANGEEN ARI	53/28	23	4	30	4	31	8
FEB	12	0			22	12	29	12	31	8
MAR	11	12			22	4	29	4	30	4
APR	14	4	BAISAKHI	51/30	24	4	31	4	31	8
MAY	14	8			24	8	31	8	31	8
JUNE	14	0			23	12	30	12	31	8
JULY	14	0			23	12	30	12	30	8
AUG.	13	8			23	4	30	4	30	8
SEPT	14	0			23	12	30	12	32	8
OCT.	15	0			25	8	32	8	34	8
NOV	14	8	RANGEEN ARI	53/28	27	8	34	8	35	0
DEC.	13	6			25	6	32	8	34	8
1913 JAN	15	4			29	0	36	0	36	0
FEB	21	0			40	0	47	0	39	8
MAR	18	12			35	8	42	8	43	8
APR	23	0	BAISAKHI	51/30	39	0	46	0	42	8
MAY	17	4			29	4	36	4	38	8
JUNE	24	0			40	12	47	12	44	8
JULY	18	0			30	8	37	8	46	0
AUG	24	0			40	12	47	12	46	8
SEPT	26	0			44	4	51	4	52	0
OCT	25	8			43	4	50	4	49	0
NOV	19	0	RANGEEN ARI	53/28	36	0	43	0	47	8
DEC	19	0			36	0	43	0	43	0

Photo Zinco, August, 1920.- No. 1178.3000.

in India a quality of lac superior to any other. It is strongly recommended that the newly constituted research branch of the Forest Department should undertake lac cultivation on an experimental scale especially on Gyo and Zi. If the former is found to produce a lac of anything like the quality it produces in India there is bound to be a heavy demand for it. Brood for the Zi tree can be obtained locally but for the Gyo tree must be obtained from the Forest Department of the Central Provinces.

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II

CHART TO SHOW EFFECT IN INVERSE OF LONDON STOCKS ON CALCUTTA PRICES, JANUARY 1901 TO JANUARY 1919.

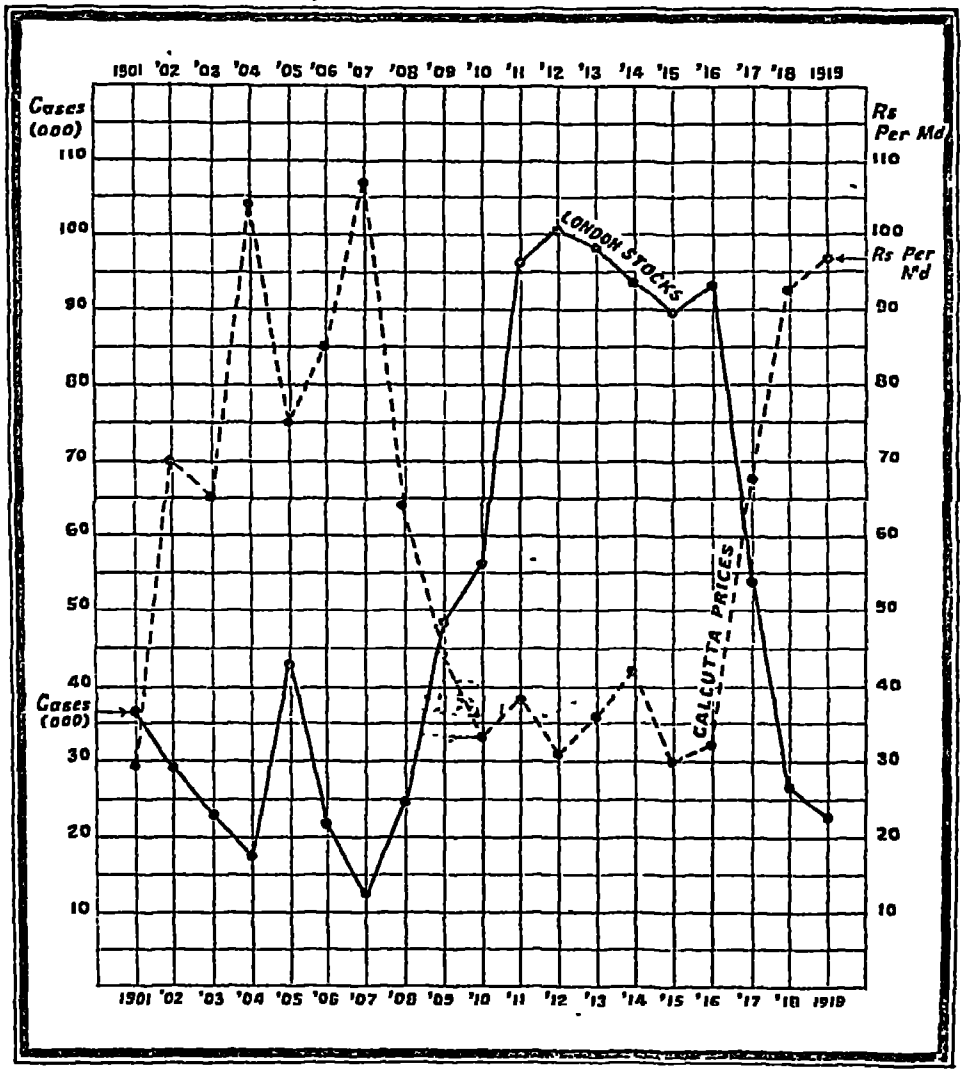


Photo. Zinco, August 1920 —No 1178-1 3000

III

CHART TO SHOW SIX-MONTHLY FLUCTUATIONS IN LONDON STOCKS OF SHELLAC JANUARY 1901 TO JANUARY 1919.

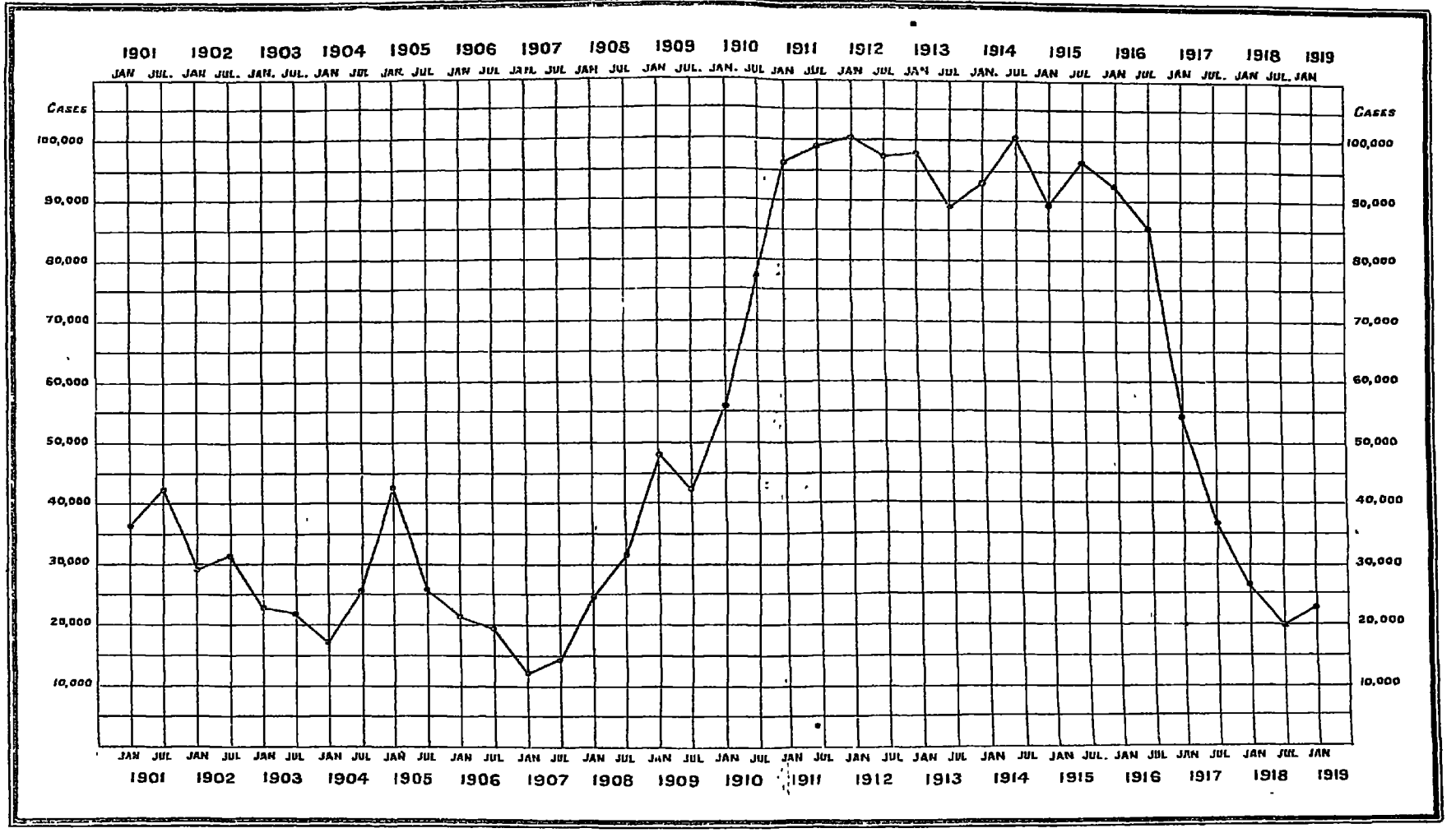


Photo Zinco, August, 1920.—No. 178-2.

IV.

CHART TO SHOW SIX-MONTHLY FLUCTUATIONS IN LONDON PRICES OF ◈FN SHELLAC JANUARY 1901 TO JANUARY 1919.

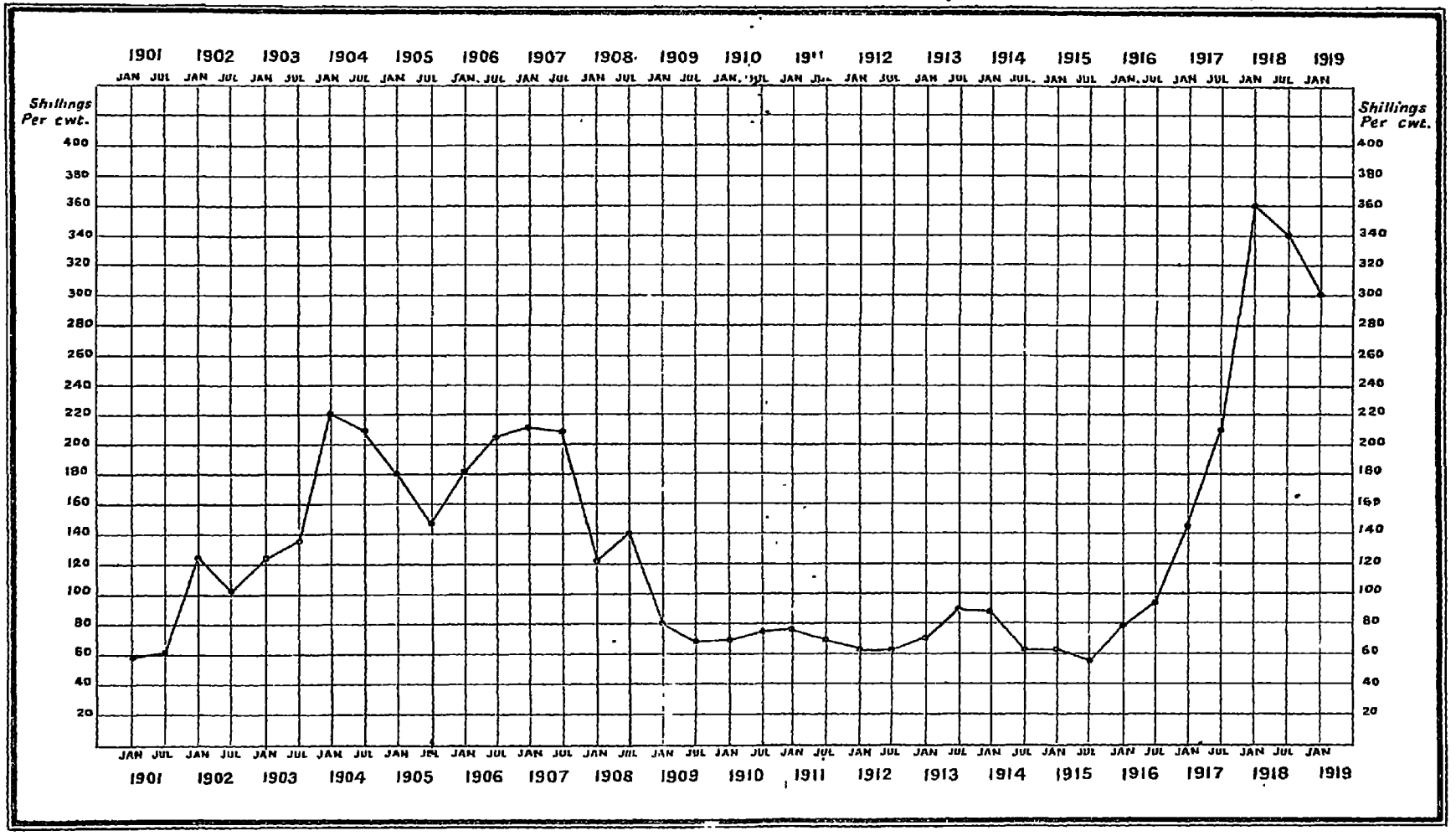


Photo. Zinco. August, 192· —No 1178-a.

V

CHART TO SHOW SIX-MONTHLY FLUCTUATIONS IN CALCUTTA PRICES OF ◇TN◇ SHELLAC JANUARY 1901 TO JANUARY 1919

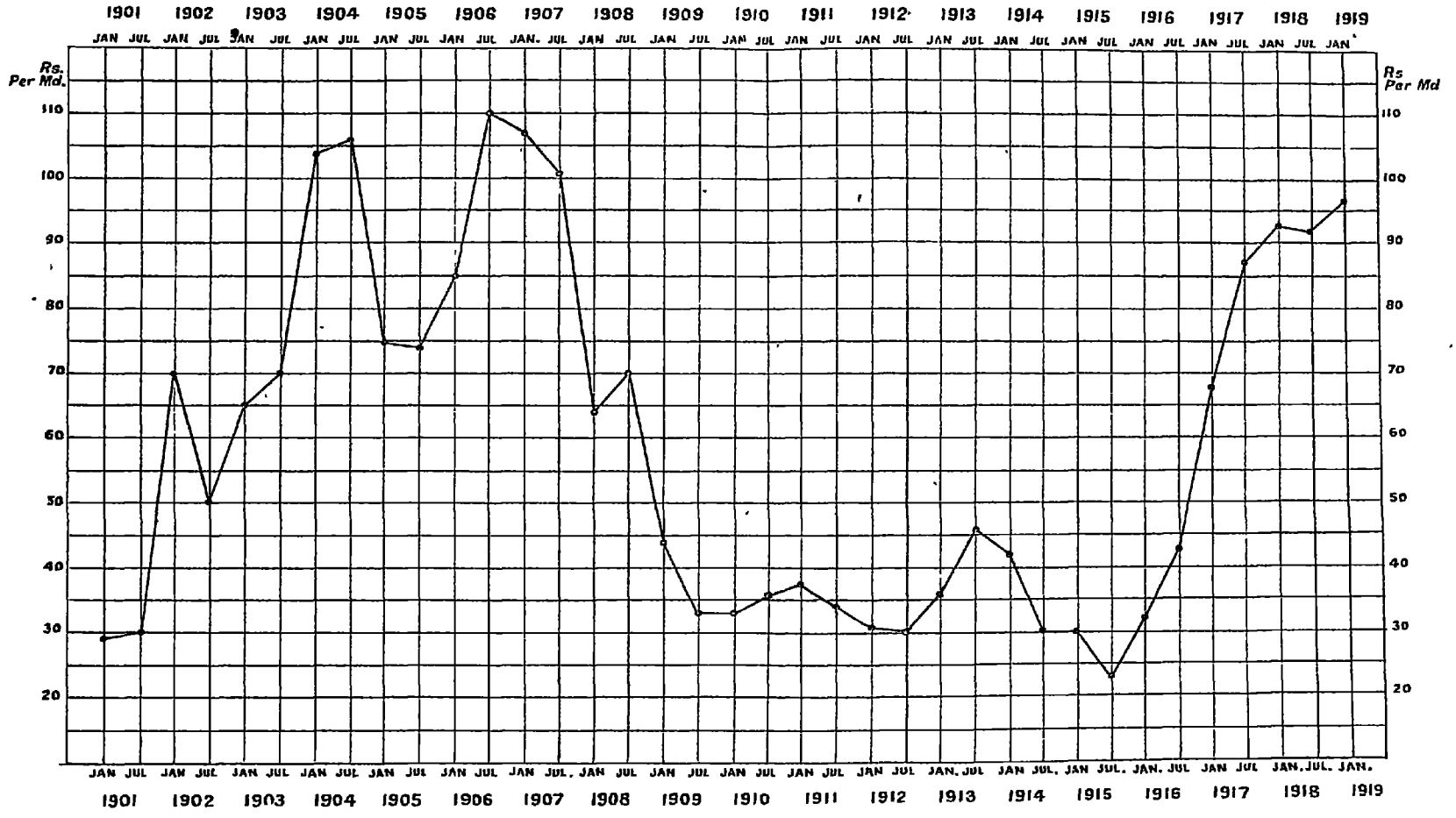


Photo Zinco August, 1920.—No 1178-4

VI.

CHART TO SHOW TOTAL EXPORTS OF SHELLAC FROM INDIA DURING EACH YEAR 1901 TO 1919

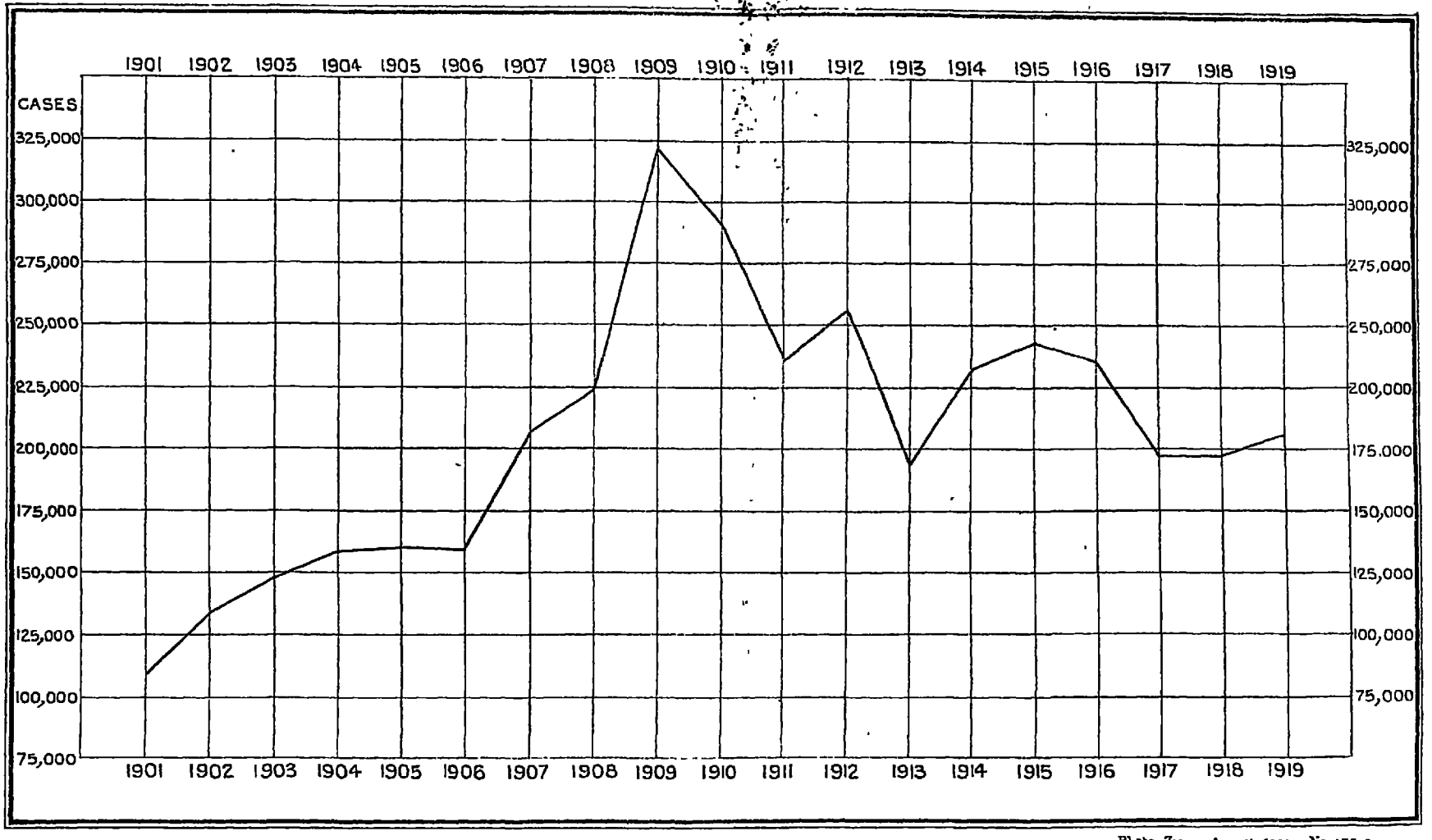


Photo Zinco, August, 1920. No. 178-5.

CHART TO SHOW MONTHLY FLUCTUATIONS IN LONDON STOCKS OF SHELLAC FROM JANUARY 1919.

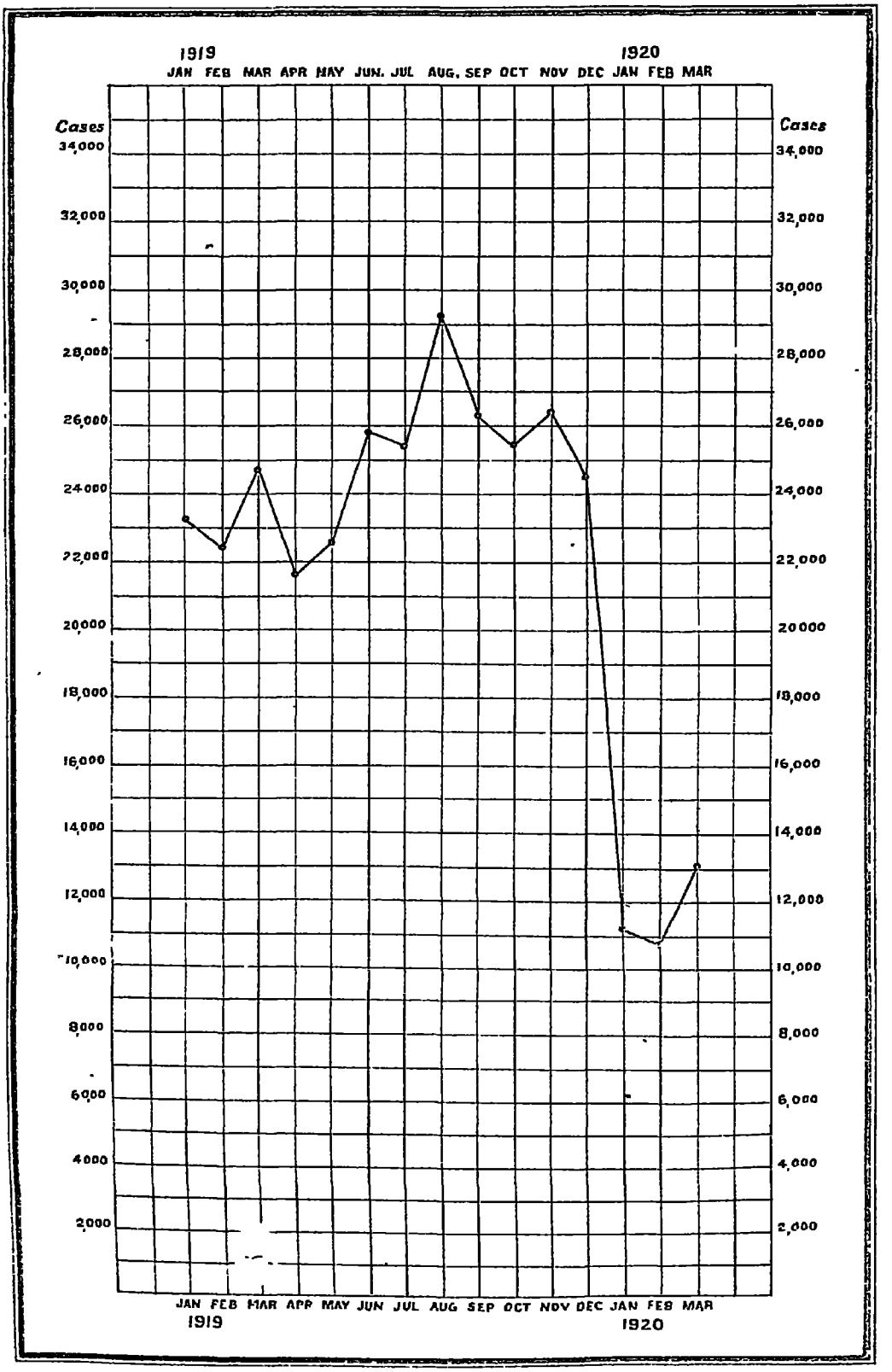
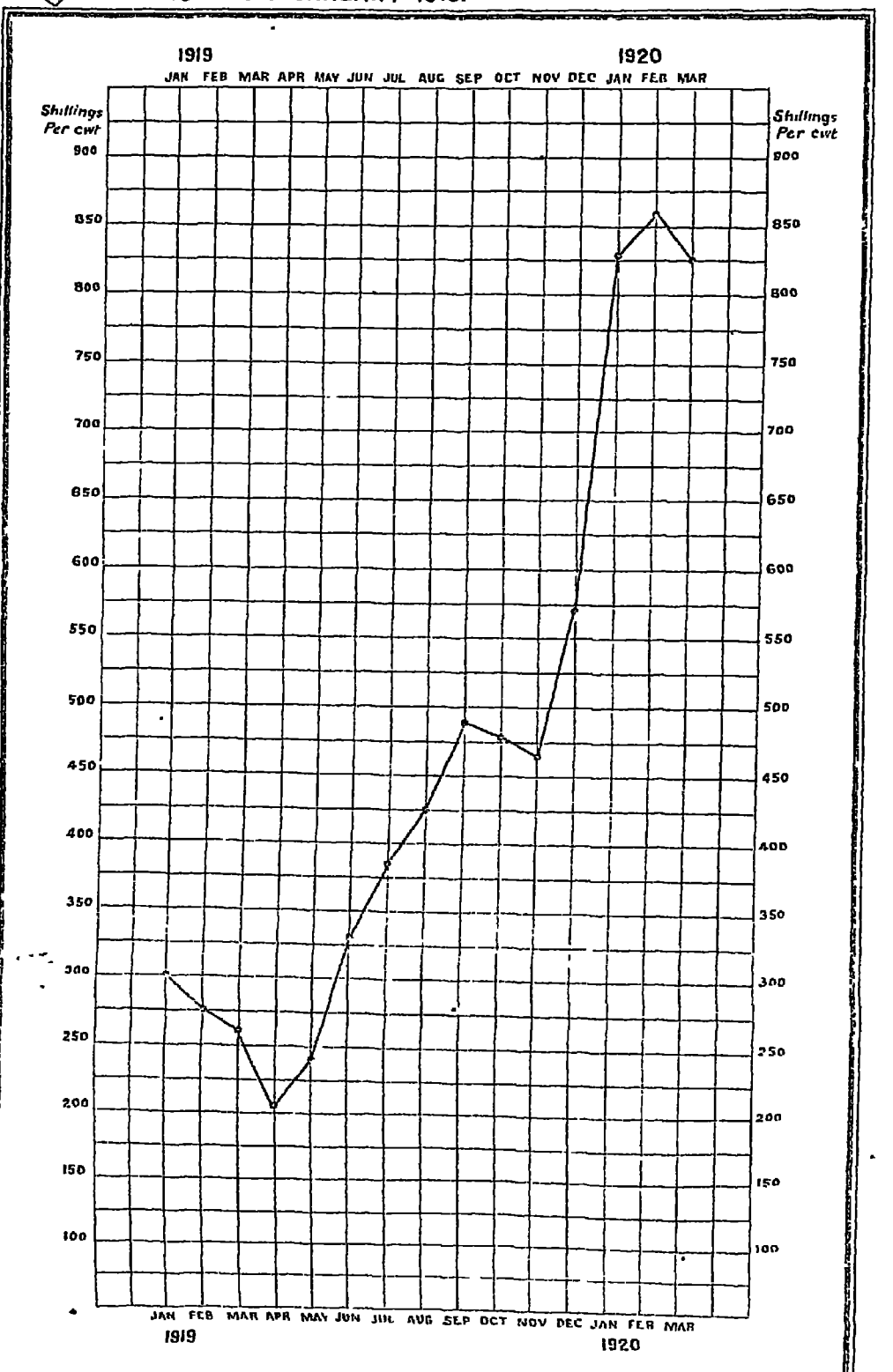


Photo. Zinco August, 1920.—No 178-6

VIII

CHART TO SHOW MONTHLY FLUCTUATIONS IN LONDON PRICES OF ◇TN SHELLAC FROM JANUARY 1919.



IX

CHART TO SHOW MONTHLY FLUCTUATIONS IN CALCUTTA PRICES OF TN SHELLAC FROM JANUARY 1919.

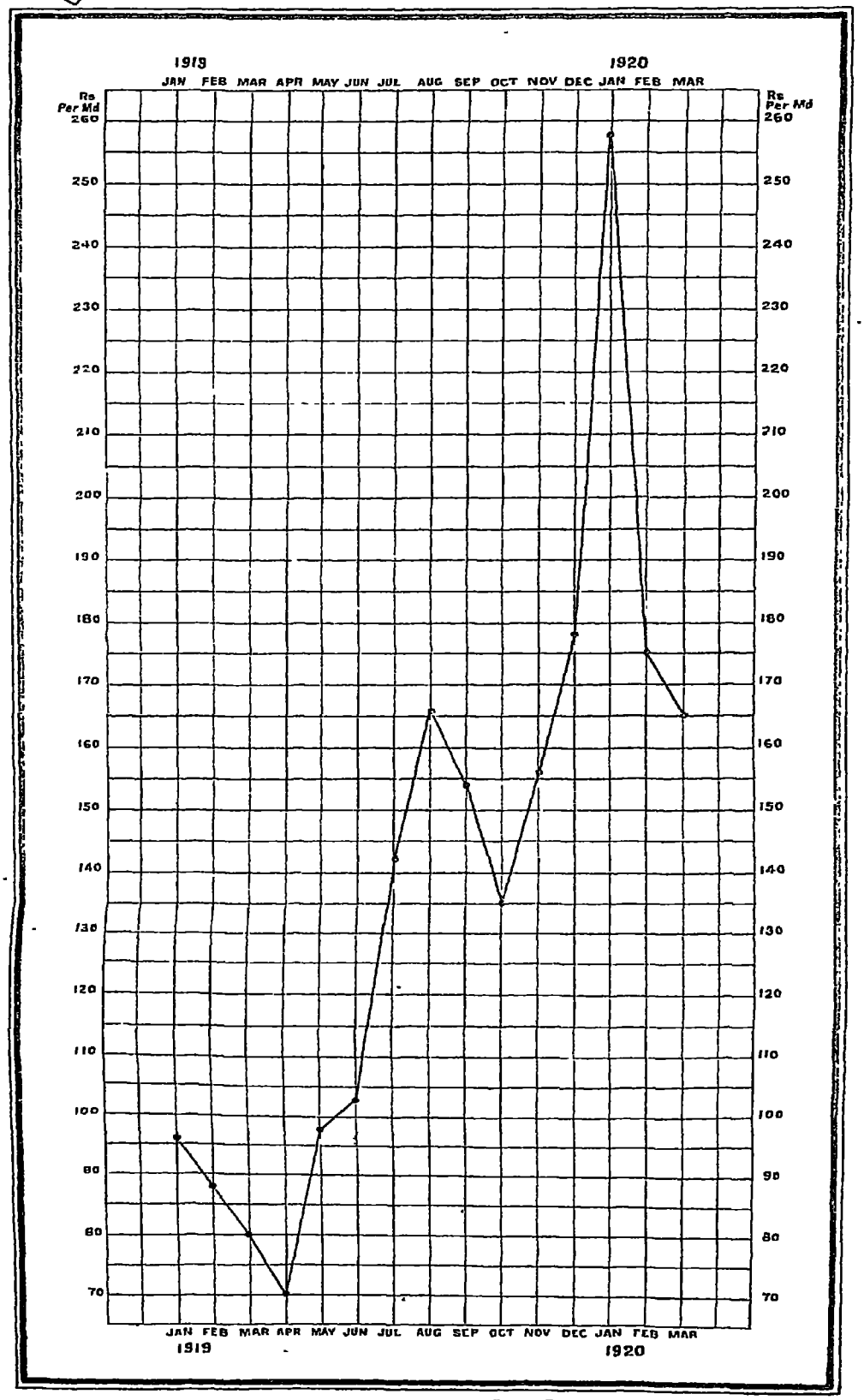
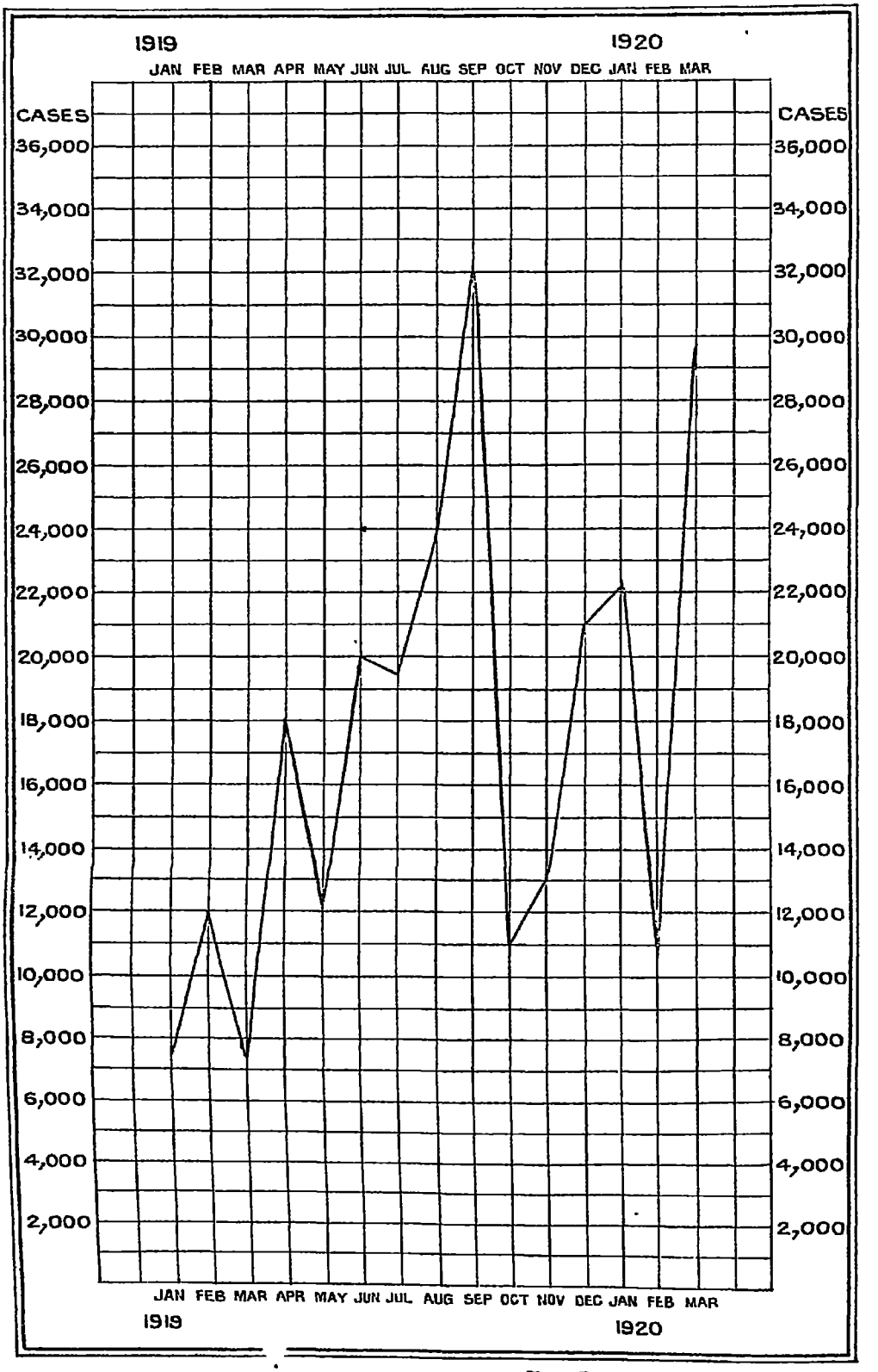


Photo Zinco, August, 1920 — No 1178-8

X

CHART TO SHOW TOTAL EXPORTS OF SHELLAC FROM INDIA DURING EACH MONTH FROM JANUARY 1919



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